Design Engineering

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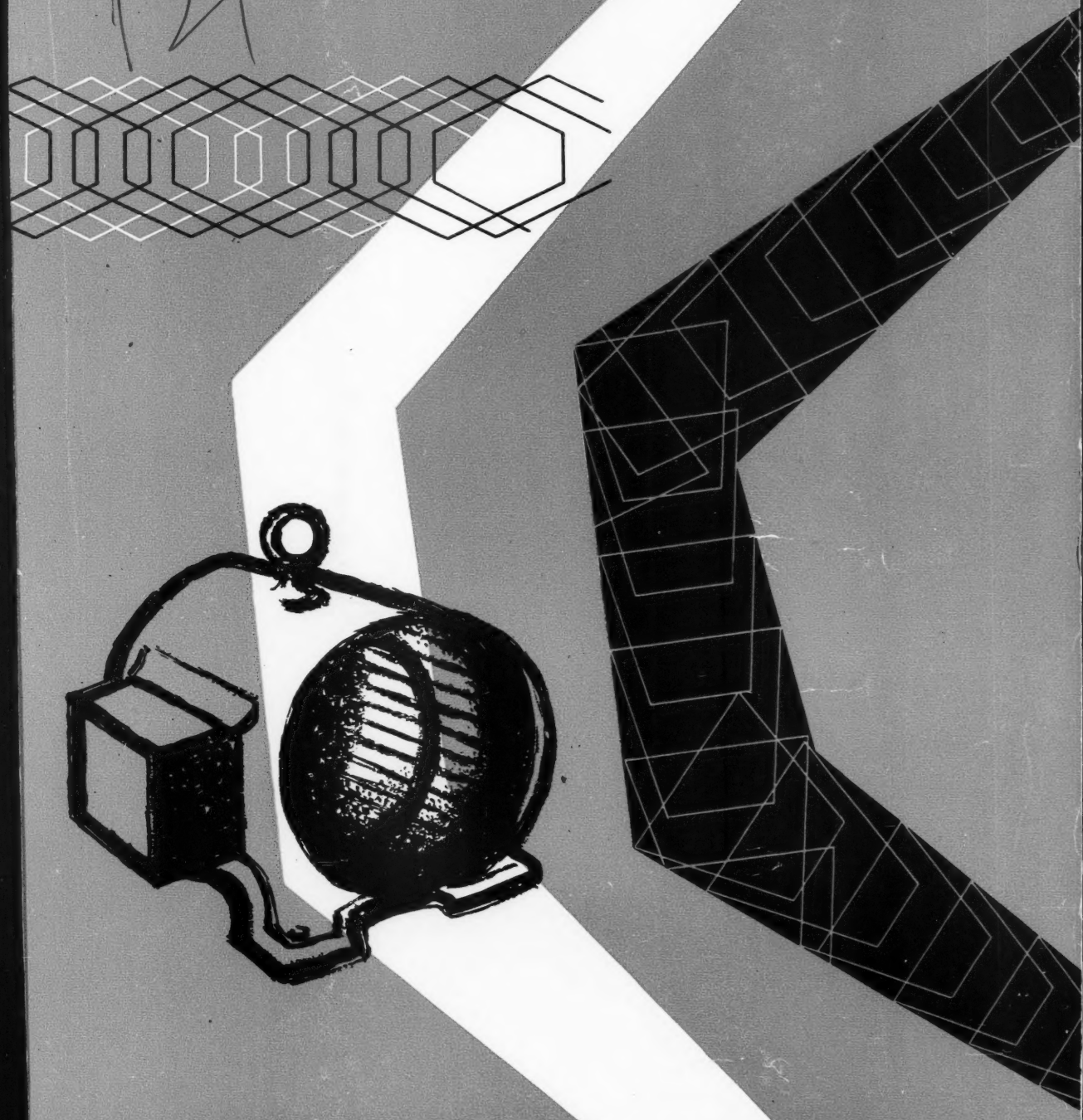
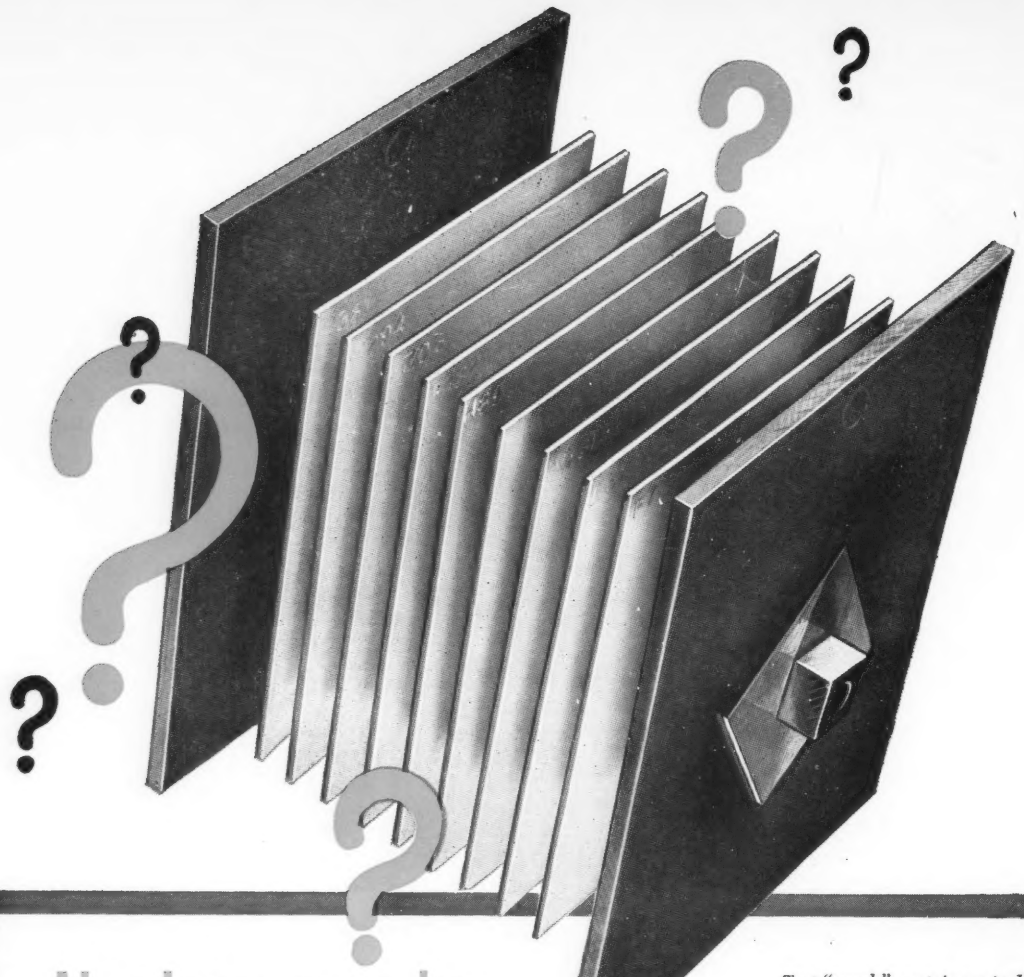


december 1956

The internals of electric motors
Design of air impellers
The latest super steels

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA



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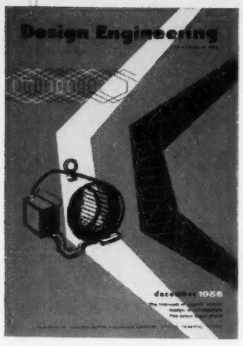

Design Engineering

VOL. 2 **DECEMBER 1956** NO. 12

This month's cover

Cover artist for the first time on Design Engineering is Gerald Bern who planned the one which graces the front of this issue. Surrounding the gaping mouth of an electric motor are patterns representing various types of winding. These repeat themselves in larger and bolder symbols down the page for a startling result.

Design Engineering

MEMBER

CCAB

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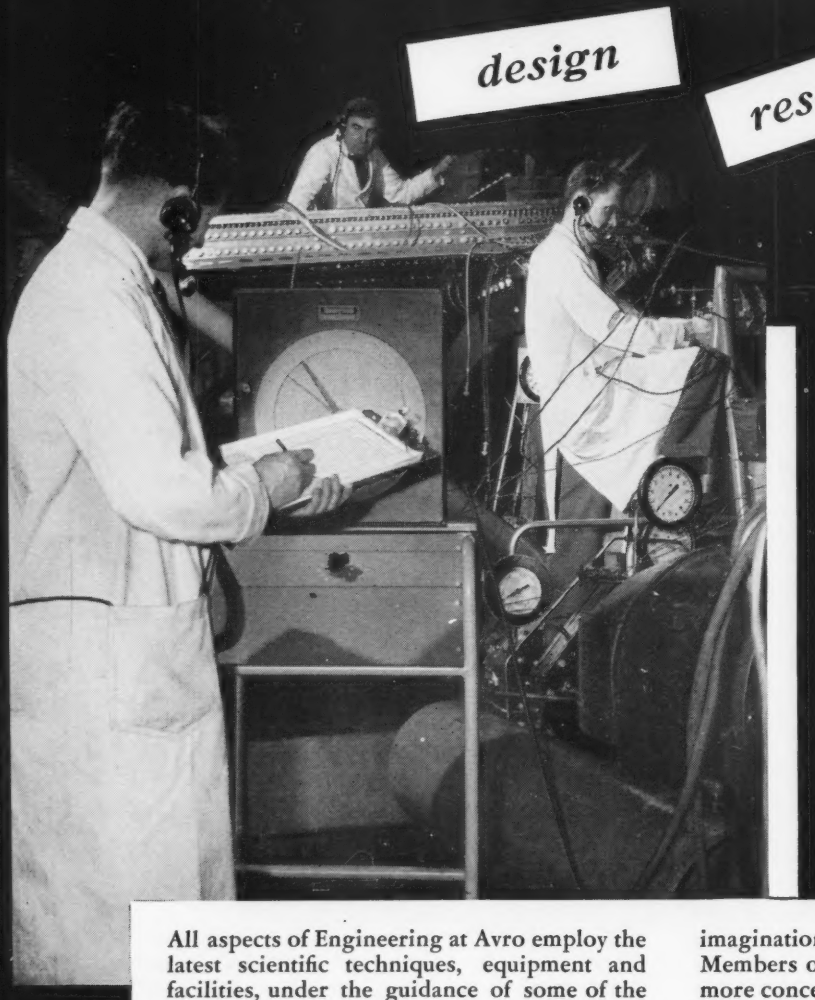

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In our next issue

Ever give a thought to the painstaking work that goes into the production of recording charts? Probably not. Our first issue of the New Year tells why they have to be so exact and how they get that way. Also in the January issue: synthetic sapphires, air blast breakers, flexible hose, Lindsay structures and silver brazing.

Inside

J. W. Fry

Our article on air impeller design comes from the pen of **J. W. Fry** who is general manager of the Torrington Manufacturing Co. of Canada in Oakville, Ontario.

Fry got his B.A.Sc. from the University of Toronto in 1937 and has held positions with Massey Harris and the Standard Sanitary and Dominion Radiator Ltd. A married man with three children, he is a member of numerous professional societies. His present position "entails travelling some thirty thousand miles per year in Canada." Hobbies of this obviously busy man are "primarily golf, watching rugby and hockey and some woodworking."

C. D. Hall, who manages their Montreal service department for Bepco Canada Ltd., contributed this month's article on the importance of internals of electric motors. Hall is a man with over thirty years' experience in the maintenance, service and repair of electric motors and rotating machines. He's an associate member of A.I.E.E., a member of the Board of Trade Associates and a past president of Montreal's Electrical Maintenance Club. Relaxation takes the form of photography and much spare time is spent in his well-equipped darkroom. Other hobbies include travel, fishing and business and service clubs.

C. D. Hall

Henri Pierre Tardif

Authored by **Henri Pierre Tardif,** our article on the latest super steels comes from an expert in the field. Tardif, who heads the metallurgical laboratory at the Canadian Armament Research and Development Establishment at Valcartier, Quebec, has a B.Sc. from Laval University, an M.Sc. from Carnegie Institute of Technology and a Ph.D. from the University of Birmingham — all in metallurgy. He has had numerous essays and articles published, many of them prizewinners. As hobbies he lists tennis, fishing and mycology (our dictionary tells us that this is the study of fungi.

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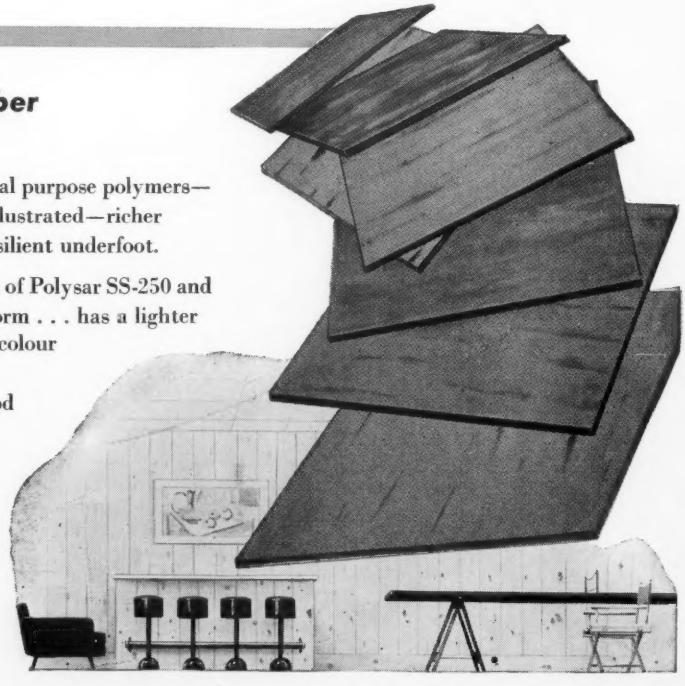

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Reports

News in brief from the world's producers

Contract to Dominion
An order for the supply of two 9,000 hp Kaplan turbines for the Shadiwal Canal Hydro-Electric Development in Pakistan has been awarded to **Dominion Engineering Company, Ltd.**

Environmental engineers
Another group of technical specialists is being formed—the **Institute of Environmental Engineers**. This institute will supersede the science section of the Environmental Equipment Institute and is being incorporated as a separate association. Engineers interested in such a movement should contact Mr. J. W. Speight at PSC Applied Research Ltd., 1500 O'Connor Drive, Toronto 16.

British technical display
One of the most important technical displays of the year in Great Britain, the 14th annual exhibition organized by the **Radio and Electronic Component Manufacturers' Federation** is to be held at Grosvenor House and Park Lane House, Park Lane, London, W.1., from Monday, April 8 to Thursday, April 11, 1957. For overseas visitors and other special guests a preview is being held from 10 a.m. to 2 p.m. on the first day, April 8. Admission is by ticket obtainable from the Secretary, R.E.C.M.F., 21 Tothill Street, Westminster, London, S.W.1.

New Montreal plant
Federated Metals Canada Ltd. has opened the second of its two new Canadian non-ferrous metal fabrication, processing and refining plants. Opening ceremonies were held on November 2 at the new Montreal location. The plant is on a 9-acre tract in the suburb of Lachine and has 40,000 square feet of floor space.

Industrial scholarship
John A. Hildon leaves shortly for the main plant (in Germany) of **Fischer Bearings Manufacturing Ltd.** on an industrial scholarship. Hildon is a graduate in engineering from the University of Toronto and, for the past five years has been with Orenda Engines where he has been involved in the development and testing of engine bearings. He was selected by Fischer Bearings (Canada) Ltd. to spend a year in Schweinfurt. On return to Canada he will work in engineering design and as a service representative in the aircraft field.

Reactor at Hamilton College
A $1,300,000 nuclear research reactor will be built at **Hamilton College, McMaster University** in Hamilton. First reactor to be housed at a Canadian University, it is to be financed jointly by the Federal Government and a group of Canadian industries. It is scheduled for operation in the fall of 1958.

Change of name
A change of name involving the Minneapolis-Honeywell Regulator Co. Ltd. has been announced from Leaside, Ontario. The company will now be known as **Honeywell Controls Ltd.** The change has been made in the interests of brevity and to stress the Honeywell name by which the company has become generally known.

Western inventor
Two years from now, the invention of a Vancouver engineer will be in large scale production at a Connecticut factory for distribution through the U.S. and Canada via 175 outlets.

The arrangement follows the granting by **Tormag Transmissions Ltd.,** Vancouver, to the **Whitney Chain Co.,** Hartford, of manufacturing and distribution rights for the U.S. and Canada of products to be known as Whitney-Tormag magnetic drives.

The inventor is I. V. Zozulin, a former Yugoslav engineer, who is now a registered professional engineer in B.C.

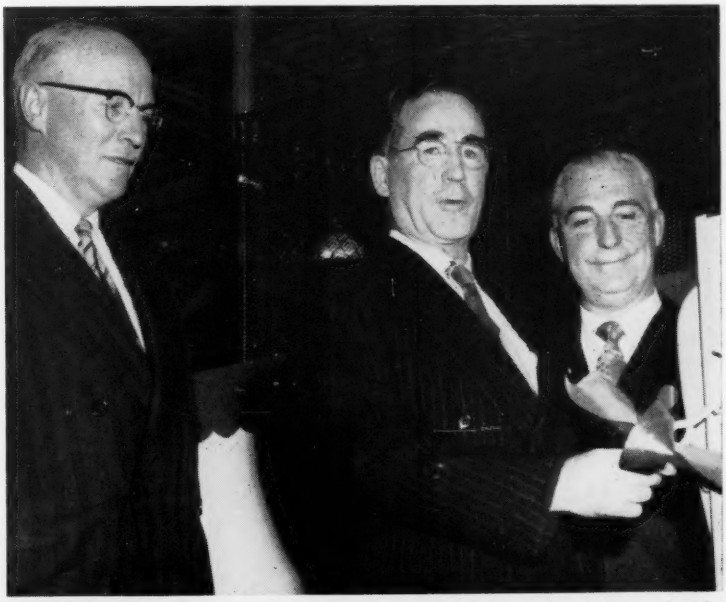
Atomic reactor contract
The contract for the construction of the building to house Canada's first atomic power reactor has been awarded to the **Foundation Company of Ontario Ltd.** Total amount of the contract for the station building work is slightly in excess of $1,000,000.

An Edmonton HQ
A headquarters for the western operations of **Computing Devices of Canada** has been established in the Commercial Building, 10120 Jasper Avenue, in Edmonton. The move follows more than a year of intensive study of the Western market potential for the specialized products of the Ottawa company.

Consulting engineers
A major challenge for a bigger share for Canadian engineers in this country's industrial development has been made by a group of Canadian consulting engineers. Under the name of **Federated Consultants Ltd.,** 12 consulting engineering firms and individual consultants have formed a new organization providing services in every important engineering field.

Though the organization was established as a private company less than a year ago, it already has two multi-million dollar projects in hand in Canada.

Premier throws the switch
Western Canada's first telephone cable plant and the west's largest wire and cable factory were simultaneously opened on October 29 by Manitoba's Premier, Douglas L. Campbell. "This is another important step forward for Manitoba," the Premier said before pushing the electrical switch that set machinery in motion in the adjoining plants of **Telecables and Wires Ltd.** and **Canada Wire and Cable Co. Ltd.**



Manitoba Premier Douglas Campbell throws the beribboned switch watched by O. W. Titus and J. R. MacDonald, prexy and v-p of Telecables. (Item above)

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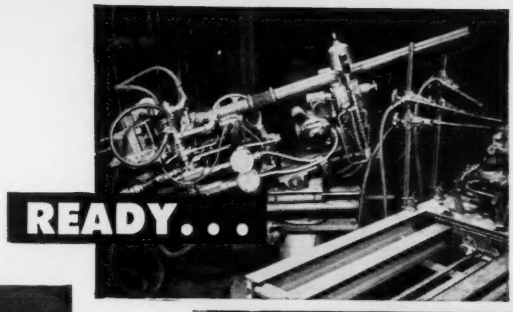
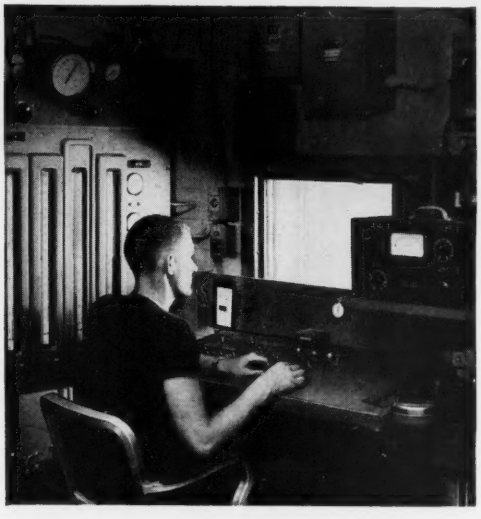
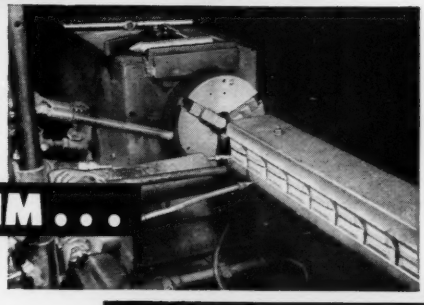
SS—16

LINDE's Flame-Plating gun is operated entirely by remote control. At control panel (below) is operator, who observes process through safety-glass window. At right, Flame-Plating gun is seen as workpiece is secured in fixture (top), as gun is brought into range (center), and at the instant of a blast in the plating action (bottom).







Not all guns shoot BULLETS ...this one gives metal parts EXTRA WEAR RESISTANCE

A dramatic and useful coating process for metal parts has been developed by LINDE engineers to provide extra resistance to wear and abrasion. This method, called Flame-Plating, utilizes a special, rapid-fire gun to apply an extremely hard coating of tungsten carbide or aluminum oxide on precision parts subject to unusual wear or fretting corrosion.

The Flame-Plating gun consists of a barrel and a mechanism for loading precise amounts of powdered coating material and explosive gases into a firing chamber. The powder—tungsten carbide or aluminum oxide—remains suspended in the gases until a controlled spark ignites the mixture.

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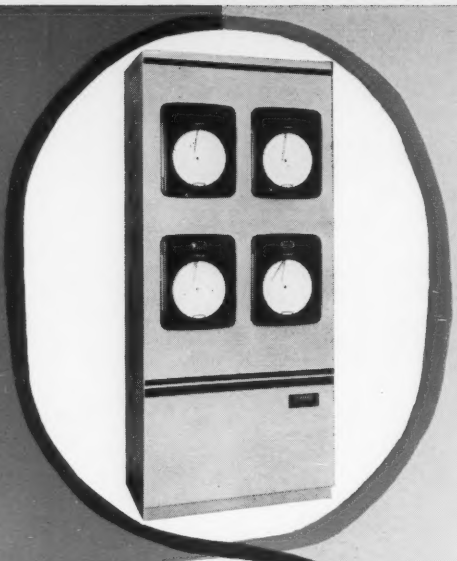

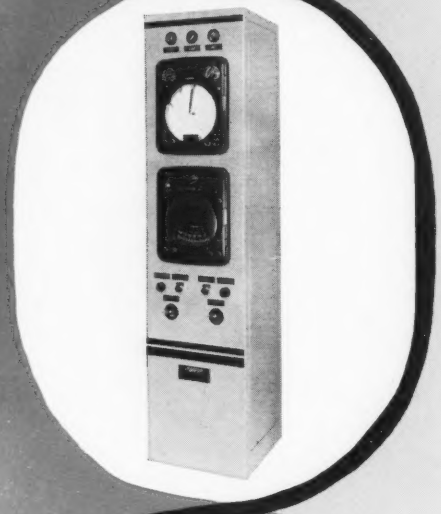

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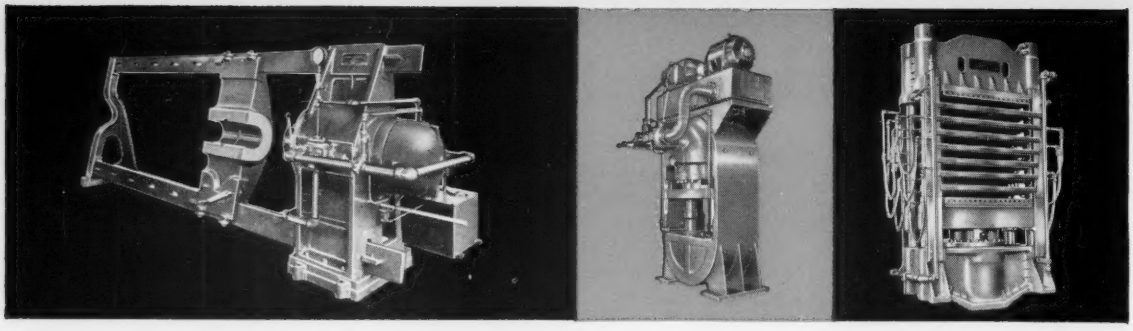

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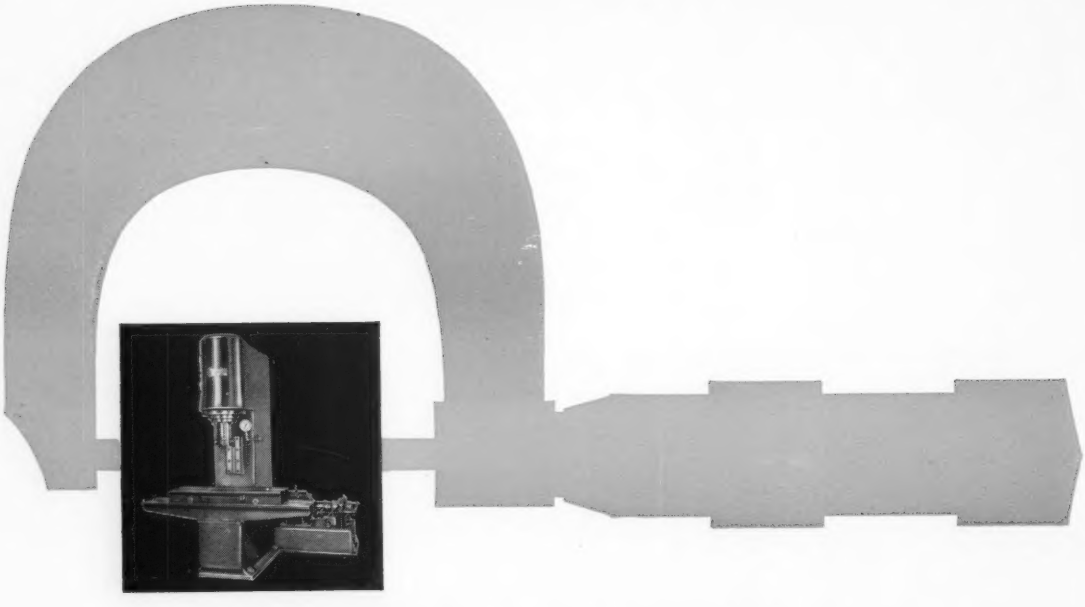

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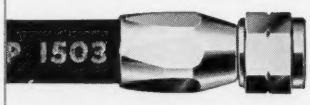
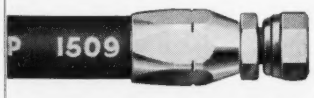


Aeroquip 1503 and 1502 Single Wire Braid Hose and Reusable Fittings are recommended for medium pressure hydraulic, lube and fuel oil, water and air lines up to 3000 psi. Sizes from 3/16" to 3".



Aeroquip 1509 Double Wire Braid Hose and Reusable Fittings are recommended for high pressure hydraulic, grease, fuel and air lines up to 4500 psi. In sizes from ¼" to 2".

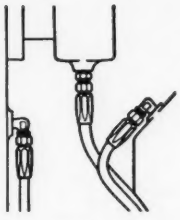
Aeroquip 2802 Teflon Hose and Reusable **"super gem"** Fittings are recommended for chemical, steam, hot asphalt and other corrosive fluid lines. In sizes from ¼" to 1 .

Aeroquip 1525 Cotton Braid Hose and *SOCKETLESS** Fittings are recommended for oil, fuel, air and water lines on engines and other applications up to 250 psi. In sizes from ¼" to ¾". *(Patent Applied For).

Write for full information

SOCKETLESS and **"super gem"** are Aeroquip Trademarks

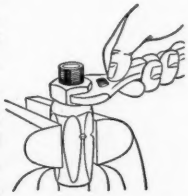
More simplified and compact fluid system designs can be achieved in many cases through proper application of flexible hose lines. The basic design advantage lies in the fact fewer "parts" are required. A single flexible hose line can be used where elbows, formed tubing sections and assorted adapters are needed using rigid tubing or piping. Flexible hose lines also offer great advantage on fluid systems subject to flexing, vibration and stress.



A wide variety of hose types is available to the designer. Aeroquip, for example, now produces 55 different hose types. Some have been developed primarily to carry special fluids. Others have been developed to withstand constant flexing, vibration, surge pressures, extreme temperatures.

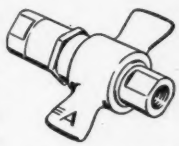
REUSABLE HOSE FITTINGS

Aeroquip Hose Lines are unique in that every Aeroquip Fitting is detachable and reusable. In designing fluid systems, reusable fittings offer two advantages. First, mock-ups can be made and modified easily using hand tools to make up hose assemblies. Second, hose assemblies can be quickly made up in production quantities from bulk hose and reusable fittings without installation of expensive swaging machines in a manufacturer's plant. This benefit is also passed on to the equipment purchaser when replacement hose lines are needed. A small supply of bulk hose and a few spare fittings can be used to make quick replacements in the field. Aeroquip maintains an extensive network of distributors to serve users of Aeroquip Hose Lines.



SELF-SEALING COUPLINGS

Where fluid lines or systems require connection and disconnection for periodic inspection or maintenance, Self-Sealing Couplings can simplify design. Replacing two shut-off valves, a Self-Sealing Coupling permits disconnection of lines under pressure without loss of fluid or inclusion of air into the system. Aeroquip manufactures six types of Self-Sealing Couplings, for general industrial use, aircraft systems, Freon systems, LP-Gas fuel tanks, railroad diesel fueling and farm implement hydraulic systems.



FREE ROUTING AND INSTALLATION GUIDE

To help in planning and installing flexible hose lines, Aeroquip has prepared a handy 16-page guide covering flexible applications, bend radii, routing to avoid abrasion, heat damage, flexing failures, etc. Write for your copy today.

Complete engineering assistance is available to manufacturers.

Aeroquip Corporation,
Jackson, Michigan
Please send_____copies of "Guide for Routing and Installation of Aeroquip Flexible Hose Assemblies."

Name_____

Title_____

Company_____

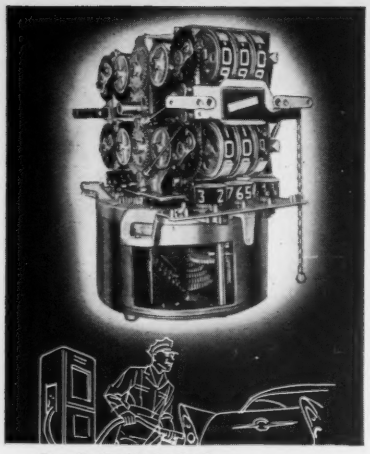
City_____ Prov._____

Aeroquip
REG. TRADEMARK

AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

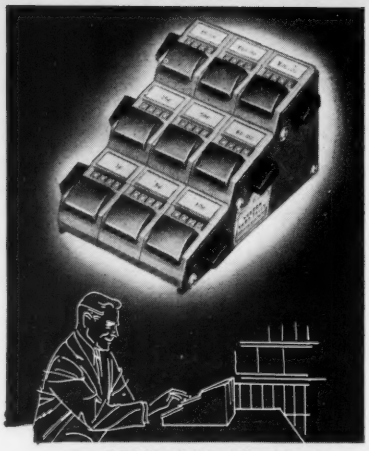
(A Subsidiary of Aeroquip Corporation)

SOCKETLESS Fitting Patents: Great Britain 740,428; France 1,088,423; Austria 185,178—Patents pending in U.S.A., Canada, and other countries.
REPRESENTATIVES IN PRINCIPAL CITIES IN CANADA. AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. AND ABROAD

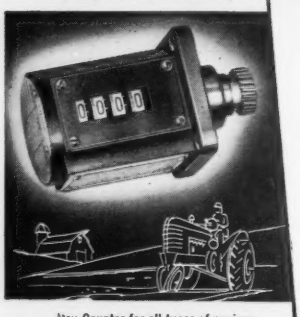


Computing Head for Gasoline Pumps

"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks



"Vary-Tally" Multi-Unit Reset Manual Counter

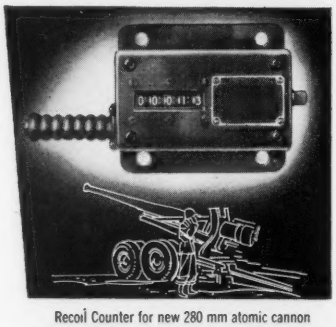


Kev-Counter for all types of engines

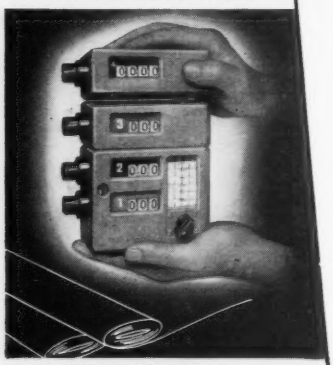
Everyone Can Count on VEEDER-ROOT

Everywhere you look in everyday life, you see a familiar face . . . the face of a Veeder-Root Counter or Computer. From gasoline pumps to fuel oil trucks to textile mills . . . in the home, on the farm, in business and commerce, in modern automated industry . . . Veeder-Root standard and special devices are keeping everything under *Count*rol . . . manually, mechanically, electrically. And the mathematical probabilities are mighty high that *you* can count on Veeder-Root, too . . . to your advantage and profit. Why not let us figure out how, *right now?*

VEEDER-ROOT OF CANADA LIMITED
955 St. James St., Montreal

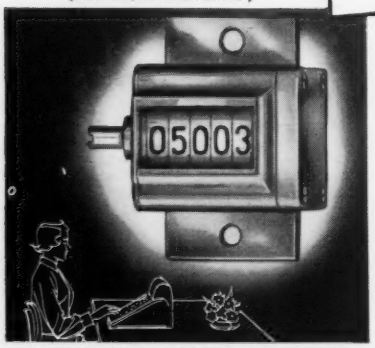


Recoil Counter for new 280 mm atomic cannon

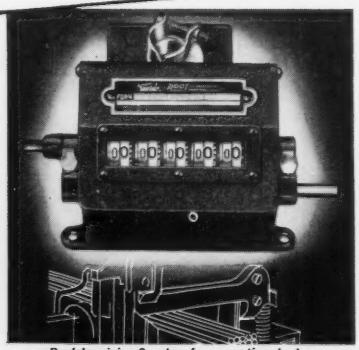


2-3-4 Convertible Counters (and others) for textile machinery

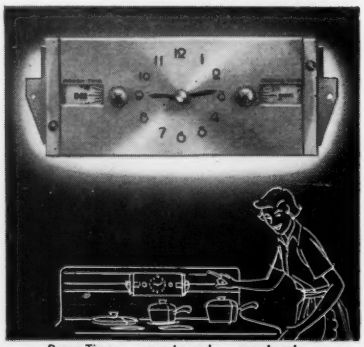
Fuel-Remaining Counter for aircraft . . . subtracts as fuel is used



Small Square-Case Counters for office and other machines



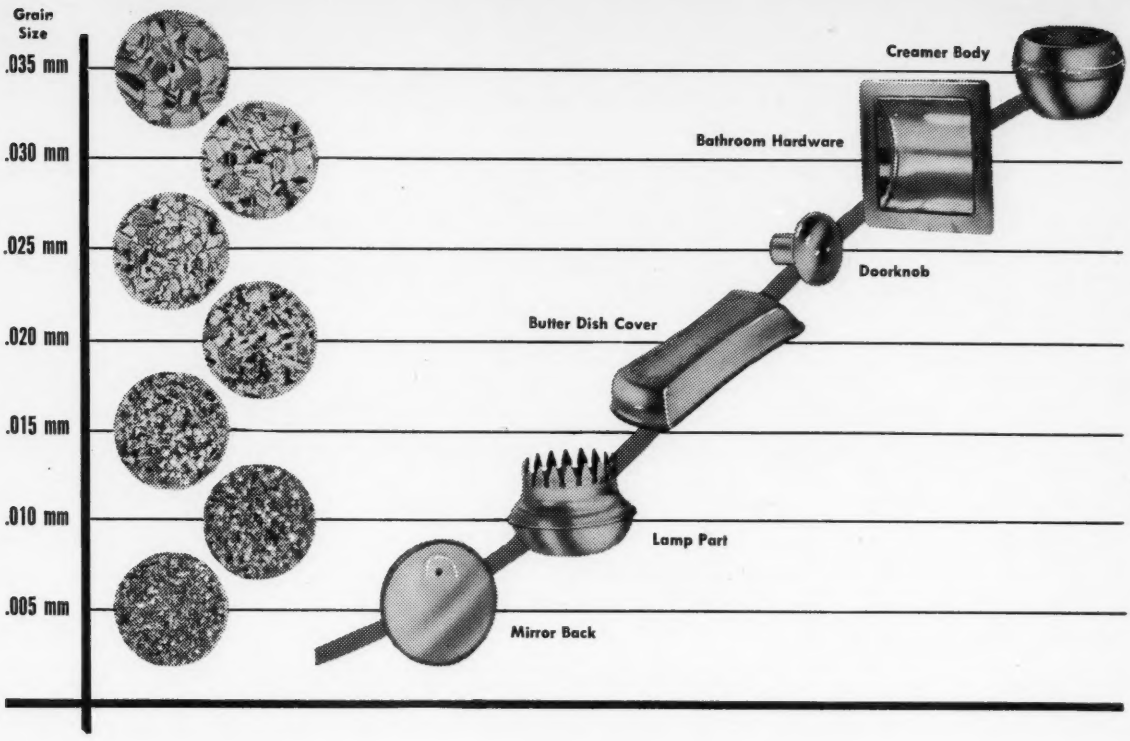
Predetermining Counters for preventing short and over-runs on production machines



Range Timer . . . easy to read . . . easy to set

Main Office and Factory: Veeder-Root Inc., Hartford 2, Conn., U.S.A. • Offices and Agents in Principal Cities

"The Name That Counts"



Which is the RIGHT Fine Grain Brass for a Job?

Write for a free copy of this folder on Grain Size— "The Fourth Dimension."

High finish on decorative brass can be produced at much lower cost by using a fine grain metal. But severe cupping, drawing and forming operations require ductility which decreases, generally, as grain size gets finer.

The right metal for the job, then, is often a compromise between fineness of grain and ductility: *no one fine grain brass can do all jobs well.*

By offering a *range* of grain sizes, Noranda can supply you with the *right* fine grain brass for every application, assuring you optimum production at lowest costs.

Noranda Technical Service will be glad to work with you in finding the right brass for your product if you will contact them through your local Noranda Sales Office.

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The less they have to work, the better!...

HERE'S ONE PLACE where cobwebs would be strictly O.K.—on piping maintenance tools. For the less they have to work, the lower your maintenance costs. Excessive valve maintenance is serious simply because the average plant has so many valves. So it's sound economics and good business to buy quality and low maintenance rather than "bargains" and frequent maintenance.

Naturally, the thrifty buyer always chooses quality valves, and for biggest value he insists on Crane. There's no greater assurance of dependable, low-cost performance . . . and the Crane line provides such quality in valves for every need.

For complete information on the Crane Valves to meet your particular requirements, ask your Crane representative, or Crane Branch—or write

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CRANE VALVES • FITTINGS • PIPING
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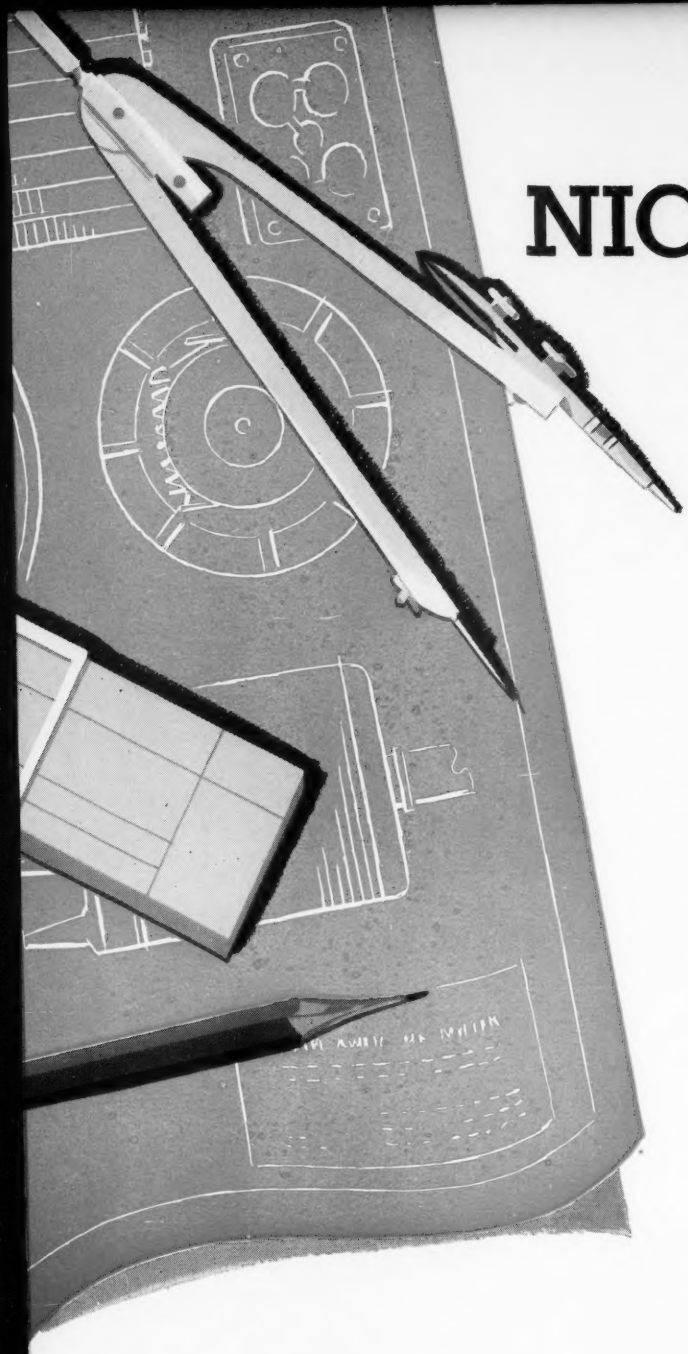
NATION-WIDE SERVICE THROUGH BRANCHES, WHOLESALERS and PLUMBING AND HEATING CONTRACTORS



Design with NICKEL STEEL for improved mechanical properties

Nickel is being utilized to assist the design engineer in an ever increasing variety of equipment. It is used extensively in the direct-hardening engineering steels where it greatly improves mechanical properties. Also the nickel-containing carburizing steels are favoured because they distort less in heat treatment and perform better in service, particularly when heavy loads are encountered.

Increased Corrosion Resistance
Proprietary brands of the weldable, low-alloy high-strength steels usually contain nickel. Such steels allow for weight reduction because they have higher yield points than the weldable grades of unalloyed steels. These materials also have better resistance to the corrosion effect of atmospheres than do the weldable grades of unalloyed steels.

Strengthens Matrix
To obtain proper mechanical properties in large forgings is much more difficult than it is in the case of the smaller sections usually involved in rolled steel applications. The properties of large forgings are therefore dependent on the alloy content. Nickel, either alone or in combination with other elements, has been the leader in this field because it strengthens the matrix, independent of the carbon content or heat treatment.

Increases Toughness at Low Temperature
Nickel definitely lowers the temperature at which brittle failure occurs in steel and is certainly the most potent element in this ability.

Many designers probably are unaware of the fact that good low temperature properties also indicate the suitability of a steel for use at ordinary temperatures under conditions of high stress concentration or rapid rates of loading.

EMBLEM OF INCO SERVICE TRADE MARK

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THE BEST MULTI-USE TESTER ON THE MARKET

Ranges

20,000 OHMS PER VOLT DC
1,000 OHMS PER VOLT AC
VOLTS, AC AND DC: 2.5, 10, 50, 250, 1,000, 5,000.
OUTPUT: 2.5, 10, 50, 250, 1,000
MILLIAMPERES, DC: 10, 100, 500
MICROAMPERES, DC: 100
AMPERES, DC: 10
DECIBELS (5 RANGES): —12 TO +55 DB
OHMS: 0-2000 (12 OHMS CENTER), 0-200,000 (1,200 OHMS CENTER), 0-20 MEGOHMS (120,000 OHMS CENTER)

BACH-SIMPSON LIMITED

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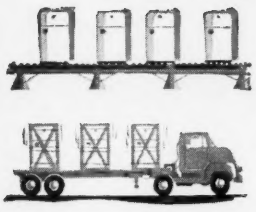
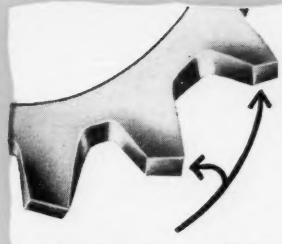
IN U.S.A. SIMPSON ELECTRIC COMPANY, 5200 W. KINZIE ST., CHICAGO 44, ILL.

Why SHAKEPROOF® LOCK WASHERS defeat vibration!

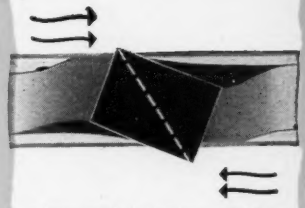


The purpose of lock washers is to keep screws and nuts tight.

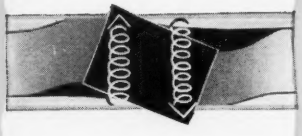
Shakeproof Lock Washers provide positive locking action that ordinary washers cannot give.



Only Shakeproof Lock Washers have these exclusive tapered-twisted teeth . . .

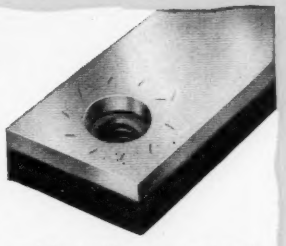


where each tooth is a strut to resist all loosening rotation of threaded fastening.

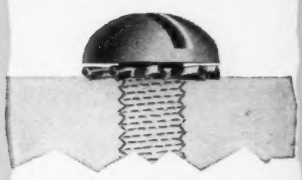


Spring tension forces the edges of each tooth to bite deeper.

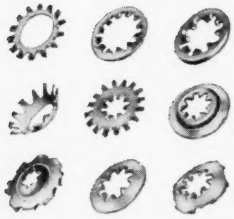
Shakeproof Lock Washers lock tighter as vibration increases . . .



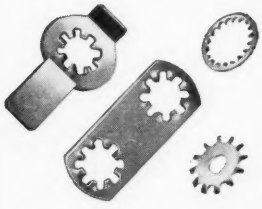
and the locking power of each tooth is multiplied by the number of teeth.



Their exclusive mechanical lock resists loosening as no other lock washer can!

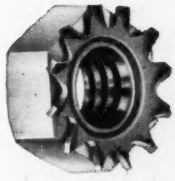


To meet the majority of your locking needs, there are nine standard types.



The variety and styles of "specials" to meet individual requirements are unlimited!

For maximum savings, buy Shakeproof Lock Washers pre-assembled on screws as SEMS.



Pre-assembled on nuts, Shakeproof Lock Washers save time—specify KEPS®.

Free Sample Kit

Now . . . make your own tests! See for yourself how SHAKEPROOF Lock Washers can save time in assembly and protect the quality of your products. Write for your free sample kit today!

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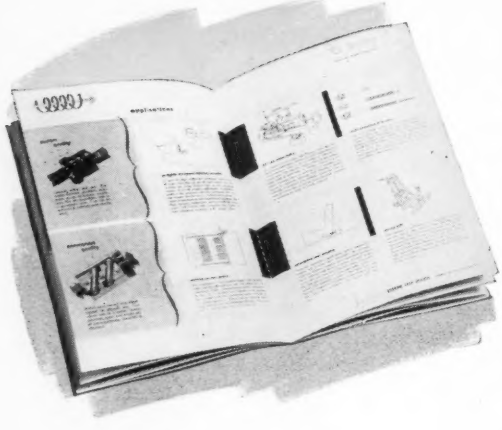
New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.



SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

Saginaw ball bearing Screws & Splines

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COMPANY_____ TITLE_____

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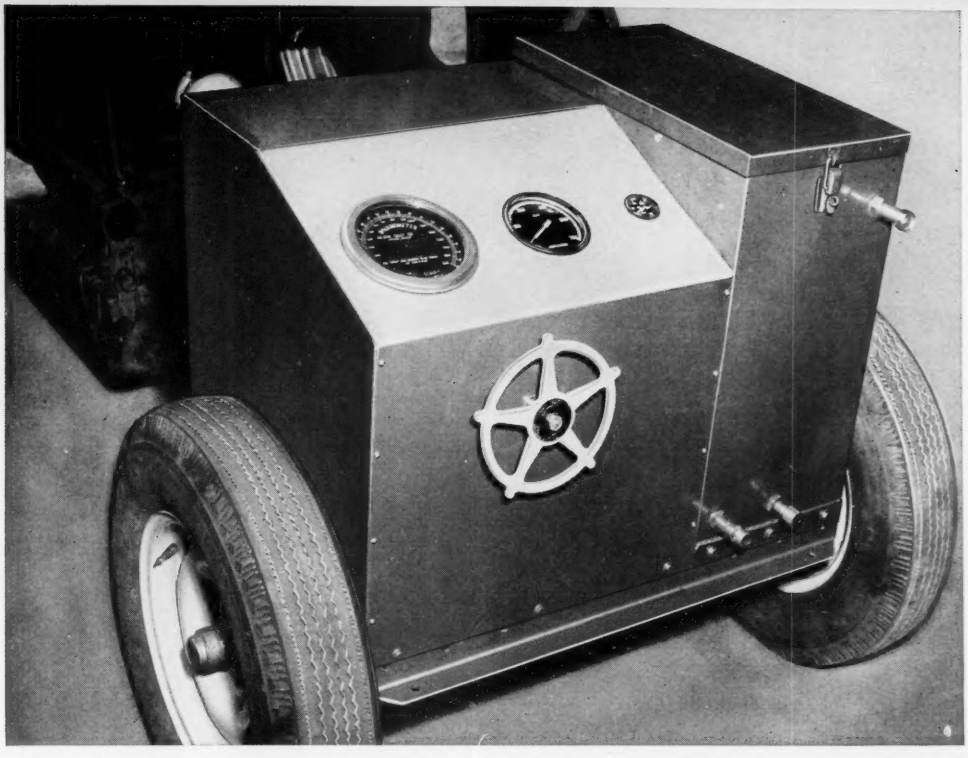


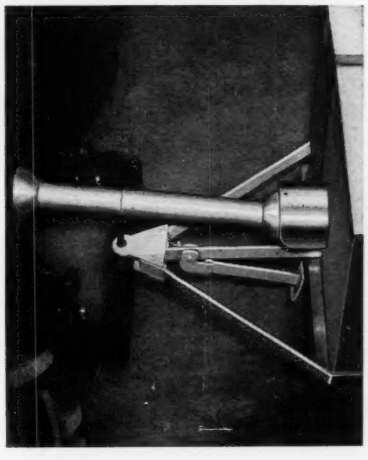
WHAT'S **NEW** AT BLOOD BROTHERS

BLOOD BROTHERS P.T.O. Drive Lines
Selected by M&W GEAR CO., Inc. for

Exciting NEW TRACTOR-TESTING DYNAMOMETER

Tractor repairmen and dealers are enthusiastic about this new test unit because it meets a real need in the farm tractor field. The only machine of its kind on the market, M&W's new dynamometer brings actual field operating conditions into the shop. Mechanics can test the pull power of farm tractors and accurately adjust ignition, carburetion and engine speed under full load for peak performance and economy.

Here's another example of the preference shown by farm implement manufacturers for Blood Brothers Drive Lines. They're selected for almost all new developments and improvements by the progressive Implement Industry because of their field-proven dependability and superiority.



Blood Brothers Safety-Shield Drive Line handles torque loads easily—and protects mechanics working in close quarters around tractor and dynamometer in garage or implement repair shop.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

TAKES POWER AROUND CORNERS

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

This is a Production Manager
(in a desperate situation)

keeping the line rolling
(on a rush order)

by trying to bridge the gap
(requiring special components)

a dependable service on forgings could close
(from Wallaceburg, of course)

If the situation demands fast service on components it's time to call in the man from Wallaceburg. For fifty years we've been supplying industry with component parts—at the right time and at the right price.

Now, with Wallaceburg-Singer Limited producing cored brass forgings we've more than ever to offer. Call us for Cored Brass Forgings, Die-Castings in zinc and aluminum, Machined Sand Castings in brass and bronze, and Automatic Screw Machine Products in brass, steel and aluminum. **And because we have all these processes, we'll honestly and intelligently tell you which is right for your component.**

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If your plans call for these features

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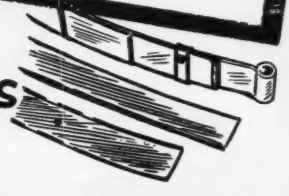
LIGHT WEIGHT

Light weight means economy wherever you use polyethylene, the lightest commercial plastic. One man easily carries a 200-ft. coil of 2-in. polyethylene pipe. Polyethylene carboys cut shipping costs of liquid chemicals. Wire and cable covered with polyethylene can be strung over longer spans, saving poles.

FLEXIBILITY

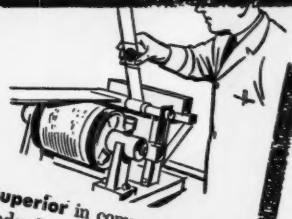
Flexibility is an inherent feature of polyethylene. It needs no plasticizers to make it resilient. The degree of its flexibility depends on its wall thickness. Squeeze bottles made from it recover their shape instantly. This quality means lower breakage costs for articles made from polyethylene.

TOUGHNESS



Toughness is another valuable property of polyethylene. A good example is this auto spring leaf pad of molded polyethylene. It stands up under constant squeezing and acts as a "dry lubricant," preventing metal-to-metal contact. It keeps out sand and grit that could abrade the metal spring leaves.

ABRASION RESISTANCE



Abrasion resistance is superior in comparison with rubber-type compounds. In laboratory test using a revolving drum covered with "Aloxite" 320 metal cloth to provide continuous abrasion, rubber-type compound lost 75 to 80 per cent thickness in only 280 revolutions. Polyethylene lost 40 to 45 per cent in 2000 revolutions.

How to Control Corrosion on Bare Aluminum

Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

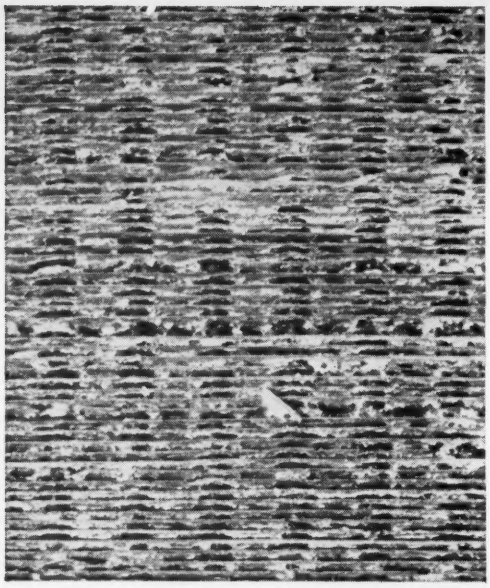
The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

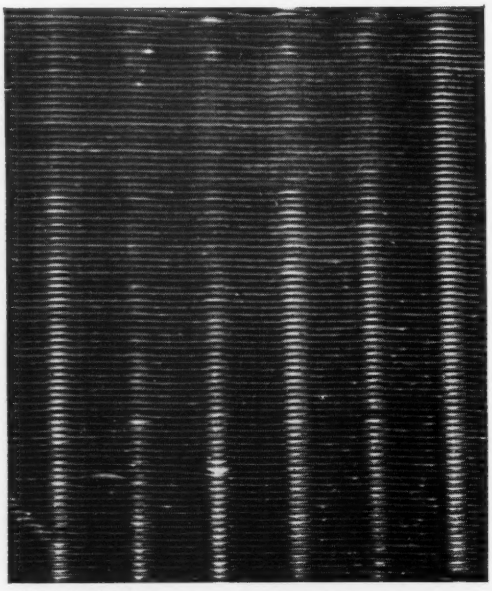
Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

The Parker man in your territory has valuable experience to share with you in treating aluminum and its alloys. A letter or phone call will bring him to you.



UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

SINCE 1914—LEADER IN THE FIELD

PROTECTED BY Bonderite PARKER RUST PROOF CO QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY OF CANADA LTD.
REXDALE BLVD., REXDALE (TORONTO) CANADA

BONDERITE corrosion resistant paint base

BONDERITE and BONDERLUBE aids in cold forming of metals

PARCO COMPOUND rust resistant

PARCO LUBRITE wear resistant for friction surfaces

TROPICAL heavy duty maintenance paints since 1883

Light, bright and carefree in Cyanamid plastics!

BUDD TRIMS WEIGHT in famous "Pioneer III," revolutionary railway passenger coach, with use of high-strength, fibrous glass-reinforced LAMINAC® polyester resin moldings. LAMINAC interior trim and appointments alone save some 7500 pounds! Double seats, step wells and washrooms are one-piece moldings and interior bays are reinforced LAMINAC from floor to ceiling. Tough, hard-wearing reinforced LAMINAC resists scuffing – is easy to clean, and integral color means no painting ever. If damaged, repairs are made easily on the spot and individual units can be replaced in minutes.

TO A LADY'S LIKING – the trim Remington Duchess electric shaver is housed in colorful, warm-to-touch CYMEL* melamine plastic, chosen for its resistance to heat, moisture and body lotions. It's a delight to look at in pastel pink or blue – and the color won't chip off or stain!

*Trademark

FAMILY 'INTERCOM'–that's the new Sylvania phone-radio. Cased in BEETLE® urea plastic in smart, molded-in colors, each unit is resistant to scratching, staining and warping... lightweight but strong. These are advantages in end use, in shipping and in manufacture.

There's a lasting, bright, carefree future for your product in Cyanamid plastics and resins. Take a new look at your problem; perhaps there's an answer in our melamine or urea molding compounds, polyester resins, synthetic adhesives or resins for surface coatings.

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PLASTICS AND RESINS DIVISION

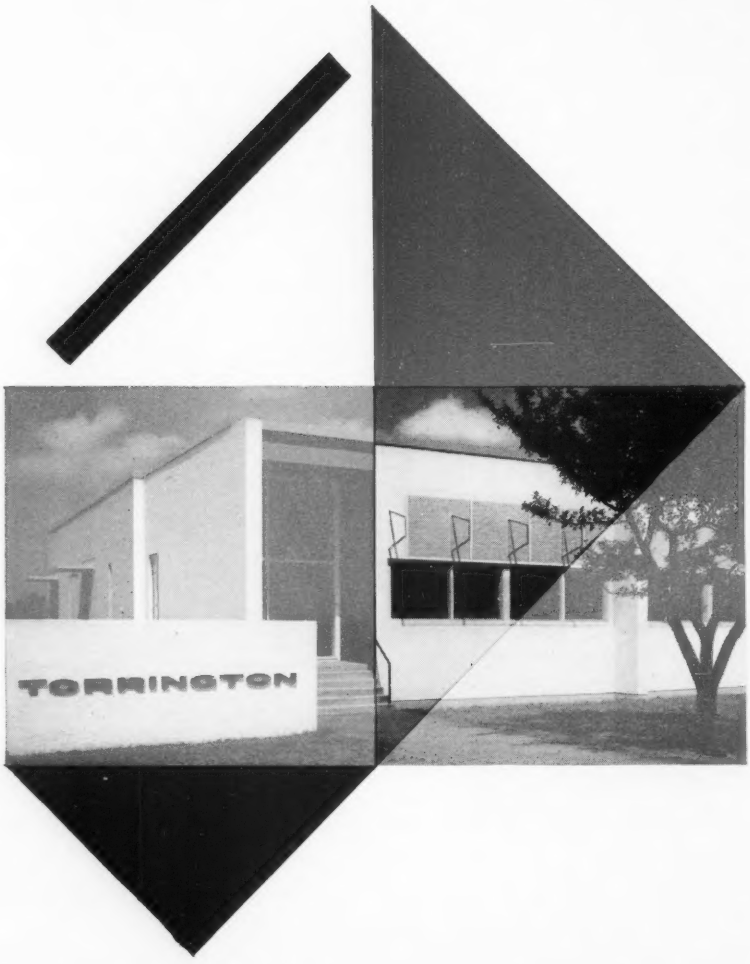
160 BLOOR STREET EAST, TORONTO 5, ONTARIO

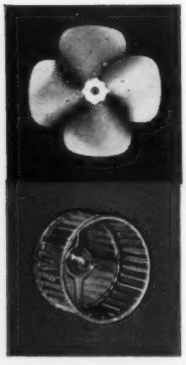
This is our factory at Oakville, Ontario, the finest Canadian plant with manufacturing facilities devoted exclusively to the development of air-impellers. If you are in the business of manufacturing air-moving products or appliances, we invite you to visit us.

Our Torrington engineers will be glad to advise you on all your air-moving problems relating to air flow, sound and vibration, and to assist you in the selection of the air impeller you need.

Call us — or come and bring your problems with you!

THIS IS TORRINGTON





THE
TORRINGTON
MANUFACTURING COMPANY
OF CANADA LIMITED
OAKVILLE, ONTARIO
TORRINGTON, CONNECTICUT · VAN NUYS CALIFORNIA

People

Important people who are in the news

Tuttle in Calgary
A western Canada technical field section of the International Nickel Company's Canadian research and development division has been opened in Calgary under the direction of **Aubrey S. Tuttle, B.Sc.**

Tuttle, a native of Medicine Hat, received his mechanical engineering degree from Indiana Technical College and then joined the staff of Canadian Westinghouse in Hamilton. During the war he served in the Ministry of Munitions and Supply and at war's end he joined Inco in Toronto.

Collins Canada appoints
Walter C. Ward has been appointed resident manager, Ottawa office of the Collins Radio Co. of Canada Ltd. Ward joined Collins from Measurements Engineering Ltd. where he had been vice-president and Treasurer since 1945. He's a graduate of the University of Toronto in electrical engineering.

Harkness to head CEMA
The Canadian Electrical Manufacturers' Association recently named **Robert Dickson Harkness** as its president. Harkness is a 64-year-old Montrealer and president of Northern Electric Co. CEMA represents more than 90% of Canada's billion-dollar electrical manufacturing industry.

Calumet and Hecla names Ervasti
E. W. Ervasti is the newly appointed general sales manager at Calumet and Hecla of Canada Ltd. Ervasti has served in various capacities with the company's Wolverine Tube division for eighteen years, having begun his career as secretary to the sales manager. He has been industrial sales manager for Wolverine since 1953.

Two scientists, two engineers
Two scientists and two engineers have been added to the General Atomic Division of Canadair Ltd. in Montreal. Joining the new division are **A. M. Harris, Dr. W. D. Bennett, Dr. A. J. Goodjohn** and **Dr. J. T. Rogers.** Harris and Bennett both hail from the land of perpetual tea and the pound sterling, Harris from London and Dr. Bennett from Sheffield. The former is to be section chief for nuclear engineering and the latter acting chief of the development section.

Dr. Goodjohn, born in Calgary, received his B.Sc. in 1950 from the University of Alberta followed by his master's degree a year later and a Ph.D. from Queen's University in 1955. Dr. Rogers received his education from St. Leo's Academy in Montreal, Notre Dame University and McGill. He obtained his engineering degree in 1948, his masters's degree in 1950 and Ph.D. in 1953. He is now in charge of mechanical engineering and thermal problems on nuclear projects.

Two V-Ps at Union Carbide
Both **Donald J. MacIntyre** and **Dr. Gordon E. Willey** were recently named vice-presidents at Electro Metallurgical Co., Division of Union Carbide Canada Ltd. This company is a major supplier of ferro-alloys to steel producers, foundries and non-ferrous metal producers.

MacIntyre graduated from the University of Toronto with a degree in electrical engineering in 1935, at which time he joined the Electromet organization. He has been general superintendent since 1954.

Dr. Willey graduated from McMaster University in 1936 with a degree in mathematics and physics and subsequently obtained an M.A. in 1938 and a Ph.D. (physical chemistry and metallurgy) in 1940, both the latter from the University of Toronto. Before joining Electromet he spent 5 years on the staff of the Ontario Research Foundation and 10 years in industry.

Wallace succeeds Burke
The Morrow Screw and Nut Co. Ltd. announces the appointment of **Mr. Don Wallace** as sales manager, succeeding Mr. W. G. Burke. Wallace is well known in the industry, having been quality control engineer of Thompson Products Ltd. of St. Catharines.

Linde Air appointments
F. Gordon Murphy, B.A.Sc., P.Eng., and **F. L. Neuman, B.S., P.Eng.** have recently been appointed general sales managers at Linde Air Products Co.—Murphy of industrial products and Neuman of special products. Linde is a division of Union Carbide Canada Ltd.

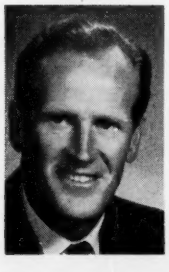
Assistant to Fred Smye
The president of Avro Aircraft has named as his assistant **Wesley V. Hurley.** Hurley was formerly Deputy Assistant Secretary United States Air Force for Research and Development Programs.

A graduate of John Hopkins University, the president's new assistant was active in the early development of turbo-jet engines in the U. S. A. and in 1951 became Technical Advisor to the Propulsion Division at the headquarters of the Air Research and Development Board.

Canadian an ASM executive
The election has been announced of **G. MacDonald Young** of Montreal as Vice-President of the American Society for Metals, the first Canadian to hold an executive office in the world's largest metals engineering society. Young is technical director of the Aluminum Company of Canada Ltd. Born in Saskatoon, ASM's new v-p was educated at the University of Saskatchewan and McGill University where he graduated in 1930 with a degree in metallurgical engineering.

Hunt of Northern Electric
Appointed general manager of Northern Electric's telephone contract division is **A. Brewer Hunt.** He's a native of London, Ontario and graduated from the University of Toronto in 1928 with the degree of Bachelor of Applied Sciences. He was awarded the medal of the British Association for the Advancement of Science. He has been with Northern Electric since 1928 and lately served as director of the electronics branch of the Department of Defence Production.

Tuttle



MacIntyre

Willey

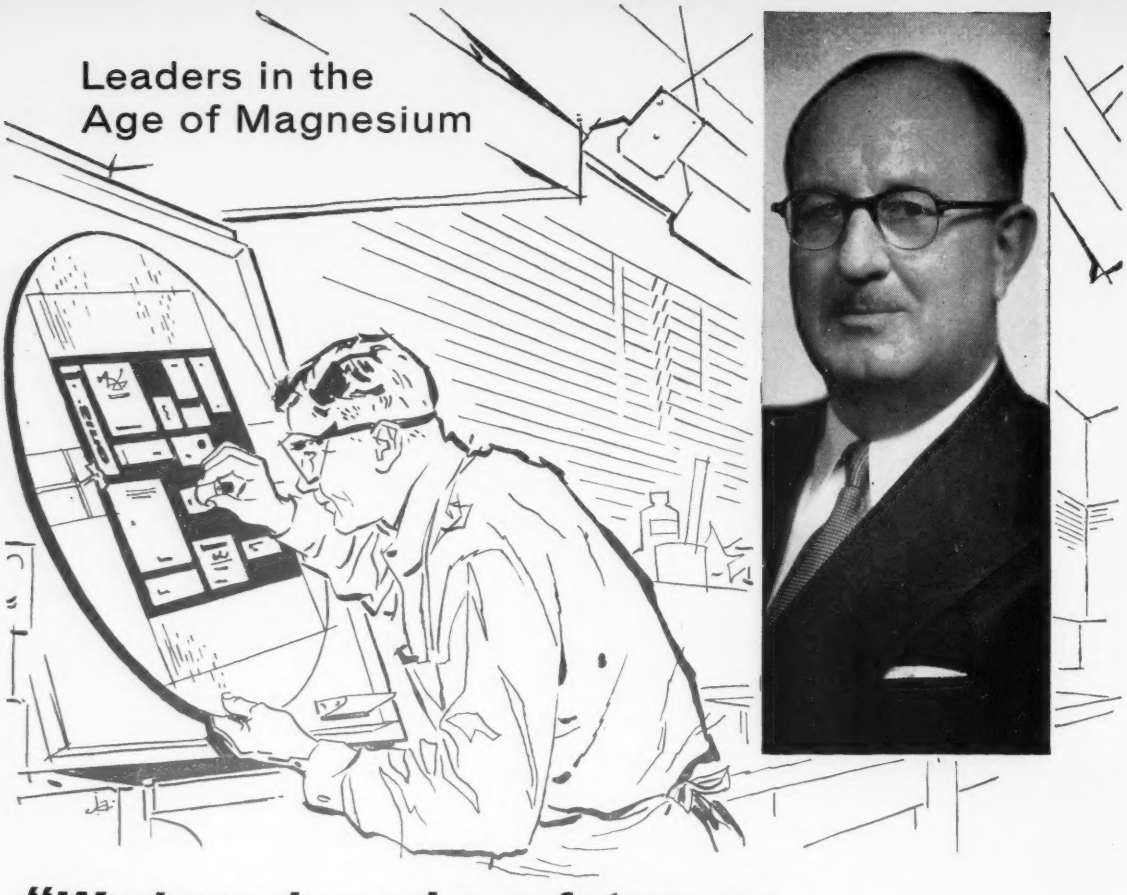
Murphy

Neuman

Young

NAKASH

Leaders in the
Age of Magnesium



"We have based our future on MAGNESIUM

"We at Brooks and Perkins based our future on Magnesium a good many years ago. We have prospered. We have found that Magnesium will do a job in economic competition with other materials in a hundred different ways. Not only have our fabricating plants in Detroit been expanded, but we were able to install our own rolling mills in nearby Livonia. Metal dealers warehouse our products, and we have offices in New York, Washington, Los Angeles and Dallas.

"Domal High Purity Magnesium is contributing to the success of Brooks & Perkins' Magnesium Printing Plates. Our Magplate Division tells us that its high quality and uniformity gives almost as much advantage over our earlier plates as magnesium has over other metals.

Extract from a letter by Mr. Howard Perkins, President, Brooks and Perkins Inc., Detroit, Michigan.

DOMAL
HIGH-PURITY
MAGNESIUM

THE WORLD'S LIGHTEST, MOST VERSATILE METAL

DOMINION MAGNESIUM LIMITED

320 BAY STREET · TORONTO, CANADA

The original engravings for this advertisement were made on magnesium

Two drawing boards and twin pantograph sit atop Perspector's main frame.

Timesaver for isometric drawings

Short cut to isometric drawing, this machine can do a good job in a fraction of the time that it once needed

When, in 1939, war sent many skilled workers to the front leaving the less skilled to take their places, many companies found themselves employing workers unable to read a blueprint. A reasonably satisfactory solution to the problem was to make use of isometric drawings. These translate "in the flat" blueprints to drawings having depth and perspective—the subject can be visualized instantly.

Isometric drawings are increasing in popularity and, apart from their timesaving feature, they are extremely useful in catalogues, instruction books and lists of spare parts where they make for rapid recognition of various components by non-technical readers.

Continued over page ▸

Isometric drawings continued

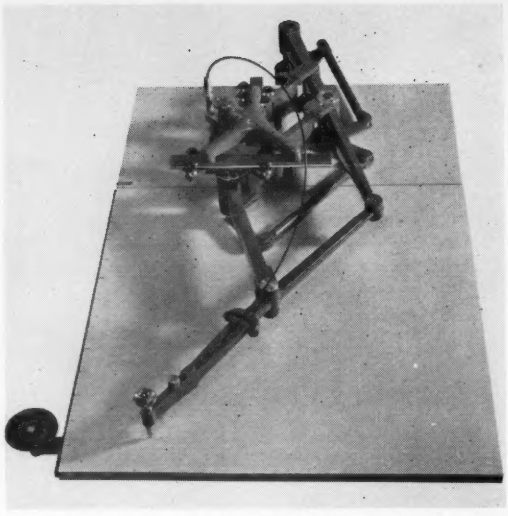
Unfortunately, however, the preparation of isometric views was, until recently, a highly skilled job and relatively few draughtsmen could turn out first-class work.

A mechanical aid to the preparation of isometric drawings has been evolved and provides the means of drawing accurate ellipses without the necessity of laborious and time-consuming plotting.

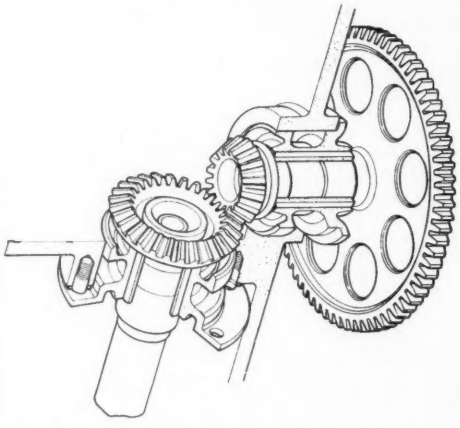
Known as the "Perspector," the instrument has two inter-linked drawing boards, on one of which an ordinary working drawing is placed and on the other a plain sheet of drawing paper. The act of causing a stylo to move over the lines of the drawing causes a pencil automatically to produce a perspective view on the drawing paper. Thus, for example, if the stylo moves through a circle an ellipse is drawn on the paper.

The instrument consists essentially of a twin Pantograph, one arm of which carries a stylo and the other a pencil collet. Normally, the pencil is held clear of the paper but when the stylo is in position over a line on the drawing, a plunger is depressed by the thumb which lowers the pencil, so that it commences to draw. Lifting the thumb immediately withdraws the pencil. The operation of moving the stylo over the lines of the drawing is extremely simple and various mechanical aids, such as radius arms for drawing circles, are provided so that, in a very short time, a beginner can produce accurate perspective drawings in a fraction of the time it would take a skilled draughtsman to make such a drawing by methods of projection. It is suggested that the device could safely be left in the hands of a competent lady tracer who could produce the inked isometric views direct on the tracing cloth using the pencil drawings as the master copy. In certain cases it is possible to produce isometric views of simple components such as bushes or shafts with several diameters without using a plan or elevation if the various dimensions are known. In such cases the different diameters are transferred by dividers to a rule direct to radius arms which enable the ellipses to be drawn whilst lengths are dealt with by means of a reducing chart.

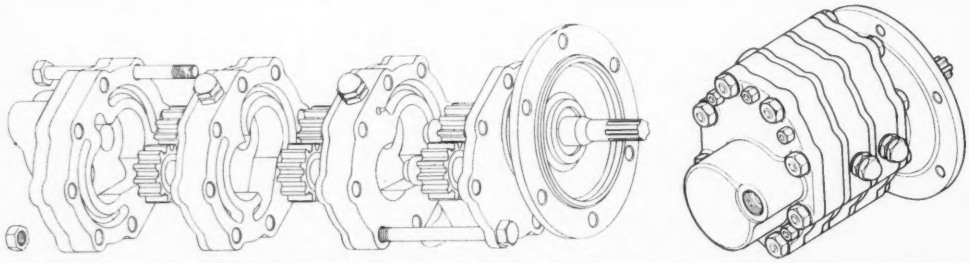
The main components of the "Perspector" are a main frame, two drawing boards and the twin Pantograph. The main frame supports the two drawing boards, one of which is fixed and the other movable, their relative positions being controlled by a small handwheel. ★



The twin pantograph can be clearly seen in this shot.



Sectional view of bevel drive done in 5½ hrs.



Exploded and assembled views of a 3-stage oil pump using the Perspector. The drawing took 9¾ hrs. to complete in contrast to a probable total of 18 hrs. for a hand drawing of similar accuracy.

What should you know about air impeller design?

The design engineer can today select from a wide variety of types, sizes and designs of air impellers to obtain the best one for a particular moving-air application. While the combination of operating requirements in such an application is usually unique, there is at least one impeller, among the hundreds of standard models developed by impeller manufacturers, that will match the requirements.

A logical step-by-step approach in pin-pointing the optimum impeller type and size is, however, necessary in order properly to take advantage of the large number of standard impellers. This article will first summarize the basic characteristics of the impeller types most commonly used in design. Selection procedures will then be given in using manufacturer's ratings and performance data.

Air-movers designed for performance

The design of air impellers is no hit or miss project. Material in this article could give you an air-moving system that performs exactly right

By James W. Fry

THE TORRINGTON MFG. CO. OF CANADA LTD.

As in selecting or designing any component, the engineer must first determine the performance and physical requirements in the air-moving system which will affect his selection of the best impeller. The primary performance requirements are: (a) rate of air flow (Q) in cubic feet per minute (cfm) and (b) static pressure (P_s) in inches of water. For a given air-moving system, both these requirements are represented by the vertical and horizontal positions, A and B, of operating point 1 on the performance curve in Fig. 1 for a representative air impeller operating at speed rpm_1. The lower curve in Fig. 1 gives impeller horsepower (hp_1) as a function of Q, with a quantity C required to produce A and B at operating point 1.

The required rate of air flow is calculated on the basis of such system considerations as heat transfer or necessary air movement, depending on the specific function of the air-moving circuit and its desired capacity. The static pressure added by the impeller (or by several impellers) must be equal to the sum of the pressure losses in the system at the required Q. Pressure losses in such flow obstructions as coils and elbows, and along ducts of various sizes and materials, are available in published literature. The total pressure loss in a system (its system flow resistance) may also be determined experimentally by test. The system flow resistance for a particular air circuit for an impeller operating at point 1, for example, is given in Fig. 1 as a function of Q. For a different system this curve would, of course, intersect the P_s-Q curve of the impeller at another point; another impeller would probably intersect the same curve above or below point 1.

A quantity frequently used in evaluating the performance of air impellers is the static efficiency, given by the expression:

$$\text{Static efficiency} = \frac{Q \times P_s}{6356 \times hp_i} \qquad \text{Eq. (1)}$$

Static efficiency can also be plotted for a particular impeller at a given speed as a function of Q (Fig. 3, axial impeller and Fig. 5, centrifugal impeller).

Of course, it is good design practice to minimize the power input for a given output by selecting an air impeller for operation in the region of maximum static efficiency, an objective that is not always possible or even desirable.

Physical requirements which should be known before selecting an impeller are: maximum space available (size and shape) and orientation of the impeller intake and discharge, both of which may affect the choice of impeller type. In designing revised models of standard equipment, like packaged air conditioning units or ventilators, the most appropriate type of impeller may already be known by experience (this should, nevertheless, be verified in Steps 1 and 2 each time.

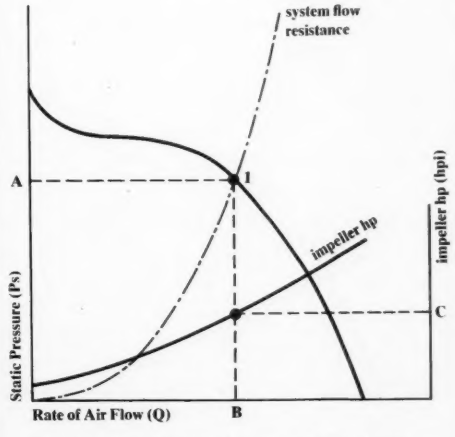
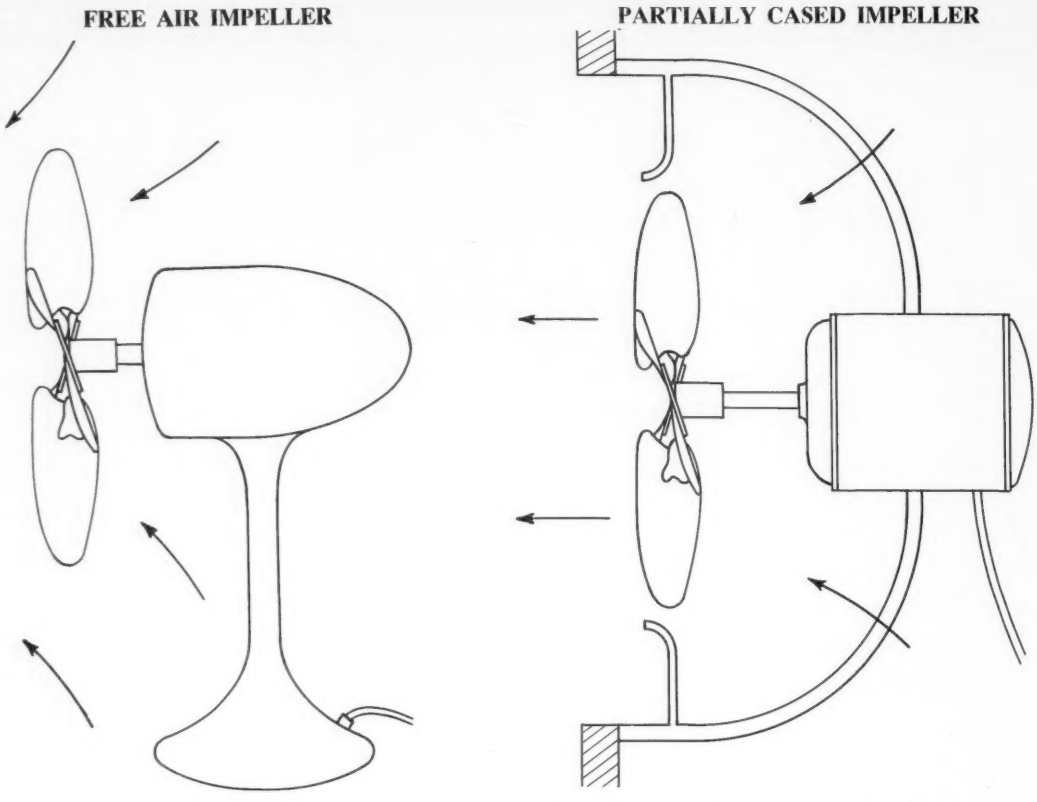


Fig. 1. Performance curve at speed rpm.



Figs. 2a and 2b. These are the two basic types of air impeller of which there are several varieties.

Air impellers continued

There are two basic types of air impeller: the **axial** and the **centrifugal,** of which there are several varieties. The following two sections will describe briefly each variety of impeller, its means of air propulsion and inherent performance characteristics.

Axial Impeller

An axial impeller is a device for moving a quantity of air or other fluid against a resistance, mostly in an axial direction. The impeller consists of a number of cambered blades mounted on a spider or hub at some predetermined angle with the plane of blade rotation. There are three types of axial impeller: free-air, partially cased and ducted.

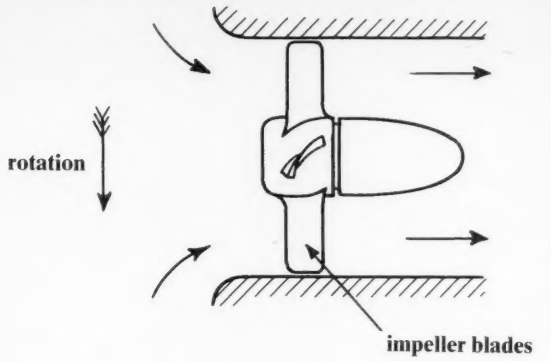
The free-air impeller, usually called a room circulator (Fig. 2a) operates within a single space and has no housing or casing. The impeller is operating with maximum kinetic energy against negligible system resistances.

The partially cased impeller (Fig. 2b), often called a propeller fan, consists of an axial impeller mounted within an orifice. It moves air from one enclosed space into another at low static-pressure differences, up to 2 in. of water. The type of orifice and position of the impeller in the orifice affect substantially its efficiency and performance.

The ducted impeller (Fig. 2c), completely enclosed axially by a duct, is used either for moving air from one enclosed space to another at moderate to high pressures or to maintain flow in a closed-duct flow system. The ducted impeller may have stationary guides or straightening vanes (vane-axial impeller) or may not (tube-axial impeller). The latter is simply an extension of the propeller fan, which can provide improvements in flow rate, pressure and efficiency, primarily because air leakage at the blade tip is reduced.

The air discharged from all three types of ducted impeller has a rotational motion and this entails a loss in energy. The vane-axial with guide vanes maintains mostly axial air flow at both intake and discharge and thereby reduces substantially this energy loss.

The curves in Fig. 3(a) give the static pressure and static efficiency as a function of flow rate for a representative axial impeller. It is evident that axial impellers are most efficient when moving large volumes of air at lower static pressures as shown by the curve.



Air discharged from ducted impellers has a rotational motion and a loss of energy

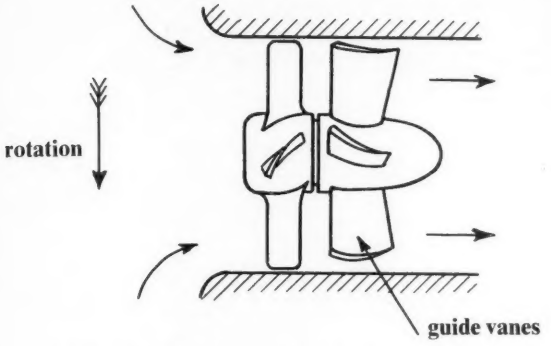


Fig. 2c. Ducted impellers, axially enclosed.

Centrifugal Impeller

In a centrifugal impeller (Fig. 4) air enters the centre of the impeller at the inlet, is accelerated by its blades and is projected from its periphery into the outlet duct. The two basic types of blade in centrifugal impellers are (1) forward-curved and (2) backward-curved.

A centrifugal impeller with forward-curved blades is primarily an impulse device, because it accelerates the air to a high velocity, while rotating at a speed usually lower than that of backward-curved impellers. The forward-curved type, known as a "volume" impeller, is much more commonly used than any other centrifugal type, since it delivers the highest air volume for a given impeller size and speed. Conversion from velocity pressure to static pressure must be accomplished in the housing and diffuser into the outlet duct.

Because backward-curved blades accomplish more than half the pressure conversion themselves, it is possible to minimize the inevitable energy loss in pressure conversion in the housing. The gentle action of the backward-curved blades means that the impeller must operate at a higher speed in order to produce the same flow rate as a forward-curved impeller of the same size.

The curves in Fig. 3(b) give the static pressure and static efficiency of a typical centrifugal impeller. Maximum static efficiencies are seen to be obtained at relatively high static pressures and relatively low flow rates.

Impeller Performance Data

Performance data published by impeller manufacturers is based on free-air and pressure tests conducted under standard conditions specified by industry codes. The engineer should consider this performance data only as a guide in selection. Thus, while the optimum impeller type and size may have been properly selected, performance of the air-moving system can only be truly evaluated by testing a prototype, taking into account differences between actual and ideal operating conditions.

Manufacturers' catalogues give dimensions of impellers, standard housings, vanes and diffusers on which the performance data is based. Any deviation from the standard dimensions and designs usually changes the published data. The impeller manufacturer should be consulted if such a deviation becomes necessary.

Performance data is presented either in the form of curves (as in Fig. 5 for a centrifugal impeller) or in tabular form. Performance curves are being more commonly used today, because they depict more clearly the operating characteristics of the impeller and the relation between the impeller and the air-moving system.

Conversion of performance requirements

In using either curves or tables, it may be necessary to convert performance requirements. Both curves and tables cover four or five common impeller speeds in the range recommended for each impeller type. When the preferred motor speed is not used in the data, the

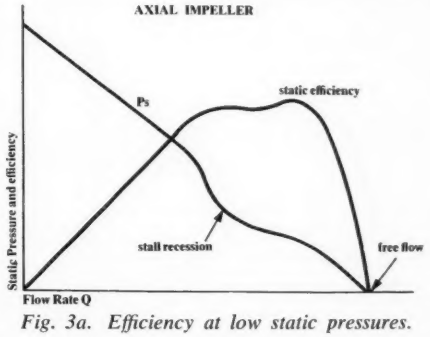


Fig. 3a. Efficiency at low static pressures.

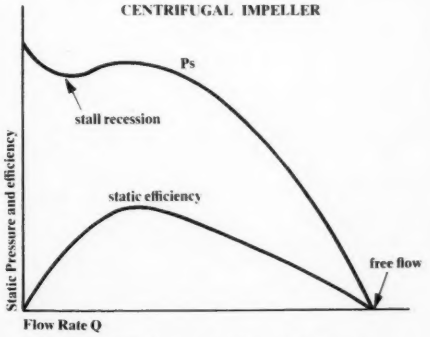


Fig. 3b. Efficiency at high static pressures.

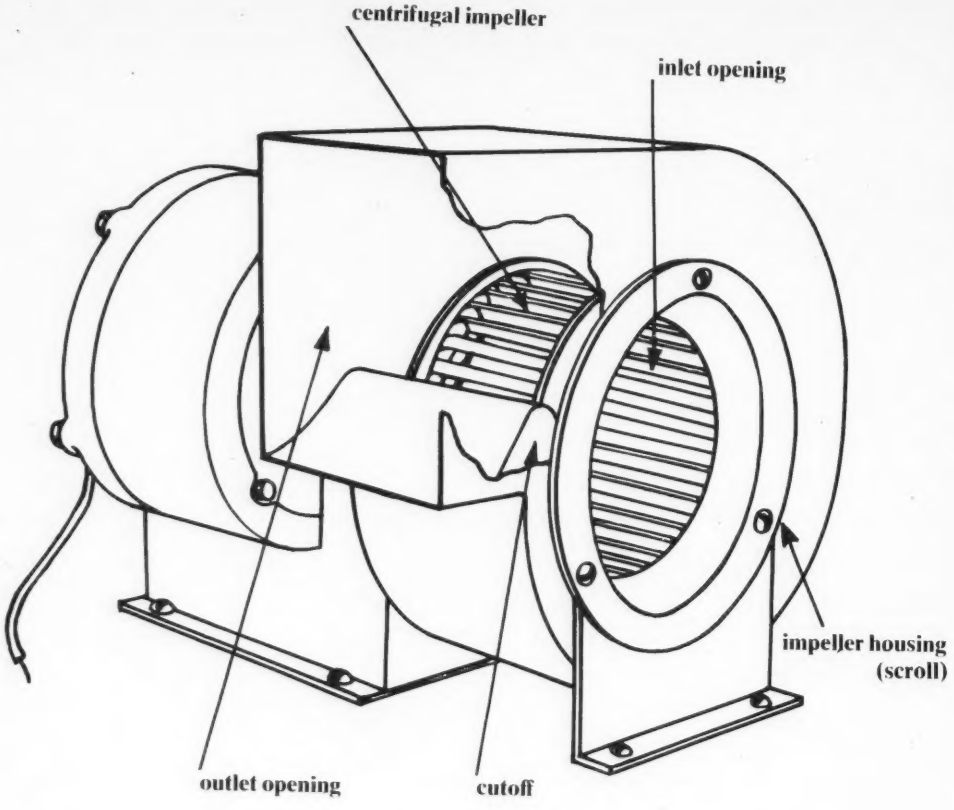


Fig. 4. Air enters the centre, is accelerated by the blades and projected from the periphery.

Air impellers continued

values of P_s and Q required must be converted in order to be able to use that information.

The following fan laws may be applied:

$$Q_2 = Q_1 \left(\frac{rpm_2}{rpm_1}\right) \qquad \text{Eq.(2)}$$

$$P_{s2} = P_{s1} \left(\frac{rpm_2}{rpm_1}\right)^2 \qquad \text{Eq.(3)}$$

where rpm_1 is the preferred motor speed and rpm_2 is the chart motor speed in the performance data to which the requirements must be converted. Actual impeller horsepower (hp_{t_1}) can be calculated from the value of horsepower (hp_{t_2}) given in the performance data with the fan law

$$hp_{t1} = hp_{t2} \left(\frac{rpm_1}{rpm_2}\right)^3 \qquad \text{Eq.(4)}$$

Both the free-air and pressure testing standards are based on a standard air density of 0.075 lb per cu ft. If the air density expected in actual operation is significantly different from the standard, it may be necessary to convert to chart static pressure:

$$P_{s2} = P_{s1} \left(\frac{\rho_2}{\rho_1}\right) \qquad (5)$$

where ρ_1 is actual air density and $\rho_2 = 0.075$. Q is independent of the density change and hp_{t_1} varies directly with density, like P_s in Eq. (5).

Specific Speed

The specific speed (N_s) of an impeller relates Q, P_s and speed at one point of operation (such as point 1 in Fig. 1) in the following manner

$$N_s = \frac{rpm \times \sqrt{Q}}{(P_s)^{3/4}} \qquad (6)$$

A particular type of impeller of given proportions, regardless of size, has its peak static efficiency at a

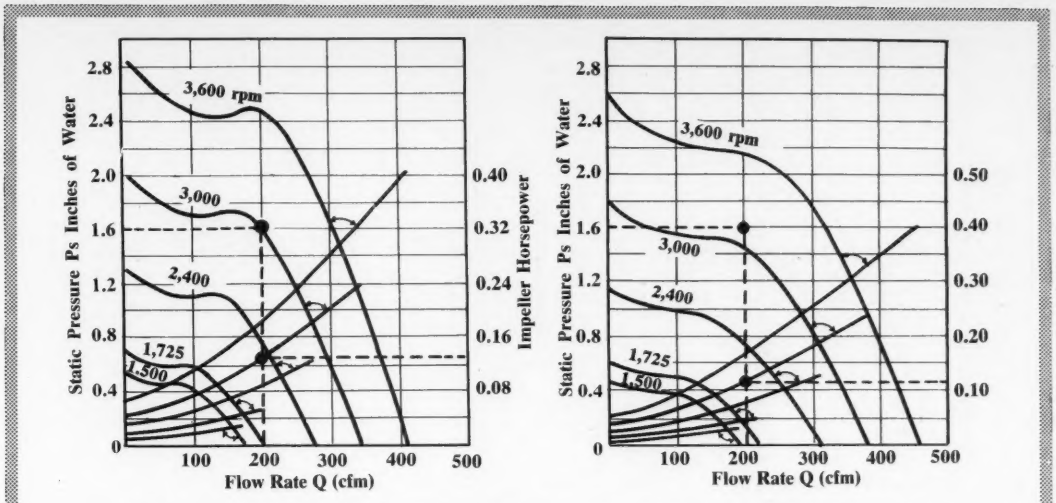


Fig. 5. Performance data represented in the form of curves for a centrifugal impeller.

single value of specific speed. It is possible, therefore, to specify ranges of specific speed within which each type of impeller operates at relatively high static efficiencies. These ranges are given in Fig. 8 for the most common types of axial and centrifugal impeller.

Selection Procedures

The following steps should be taken in selecting impellers on the basis of performance curves like those in Fig. 5:

Step 1 Determine specific speed (N_s) for the air-moving system in Eq. (6) on the basis of required Q_1 and P_{s_1} and preferred rpm.

Step 2 Determine in Fig. 6 the types of impeller in whose ranges of specific speed the value N_s calculated in Step 1 appears.

Step 3 If necessary, using Eqs. (2) and (3), convert Q_1 and P_{s_1} at rpm_1 to Q_2 at a selected rpm_2. If necessary, convert P_s to correspond to standard air density.

Step 4 Review the performance curves for each impeller of the types determined in Step 2 for rpm_2 selected in Step 3 to find those which will deliver approximately Q_2 at very nearly P_{s_2} within the normal operating range on the rise between the stall recession and free flow. If possible, in order to obtain high

(Continued on page 69)

Performance and physical factors required must be exactly determined

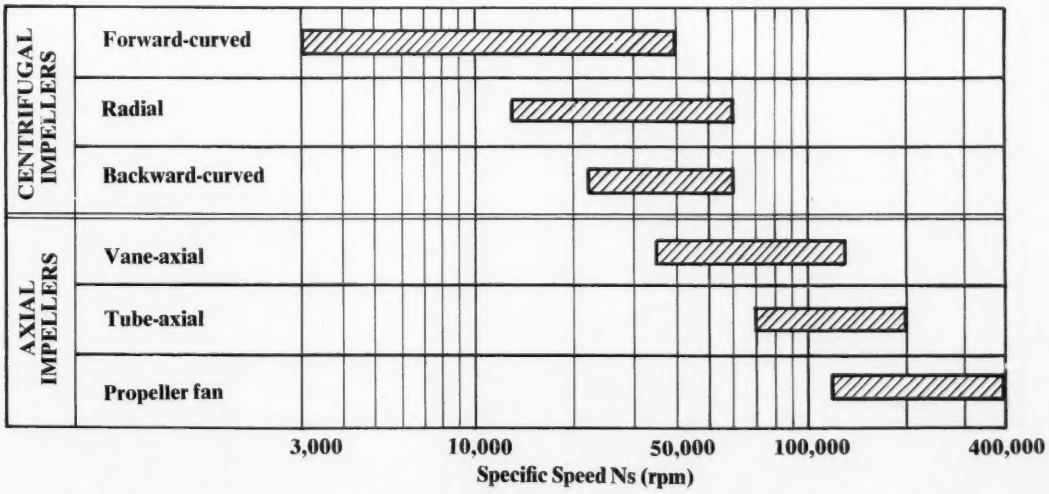


Fig. 6. Determine the types of air impeller in whose ranges of specific speed the value N_s appears.

Ideas round-up

A fibre glass laminate takes precision punching

A heat and moisture resistant grade of fibre-glass laminate makes possible a new line of precision rotary switches. This glass-cloth, silicone resin laminate, known as Phenolite G-7-830, is made into switch plates for the new 1¾ in., square, 24-position switches manufactured by Shallcross Manufacturing Company. Designed for operation up to 1,500 volts, these switches are used for RF switching, computer and instrument applications and as a general tap switch.

In specifying the material for this switch plate, Shallcross stressed the need for: (1) low moisture absorption to permit use of the switch under humid conditions; (2) wide temperature range for varying climates and to eliminate loose terminals due to heat from soldering; (4) low dielectric loss for high frequency efficiency.

Phenolite laminated fibre glass, made by National Vulcanized Fibre Company, was selected because in addition to meeting these requirements, the material also offered excellent mechanical strength, dimensional stability and acid and alkali resistance. The corrosion resistance of this fibre-glass laminate enables these switches to withstand 100-hour salt spray tests. According to Shallcross engineers, these fibre glass switch plates ensure high insulation resistance, high constant operating temperatures (200C), high mechanical strength and low water absorption.

In addition to supplying the material, National Vulcanized Fibre Co. also makes these switch plates for Shallcross. National's knowledge and experience in tool and die design for fabricating silicone parts helps them meet high quality specifications.

In the precision punching of the parts, twenty-four 0.061-in. square holes are punched 15 deg apart to form mounting holes for the contacts. At the same time, nine 0.062-in.-diameter openings are punched for the collector ring mounting. Four 0.144-in.-diameter mounting holes and a centre 0.755-in.-radius octagon with a 1/32-in. radius hole on one face are added to make the finished piece. Maximum-tolerances of 0.005 in. must be kept in punching this switch plate. (219)

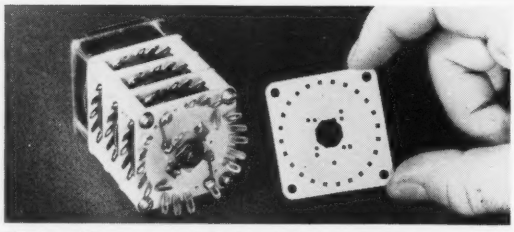
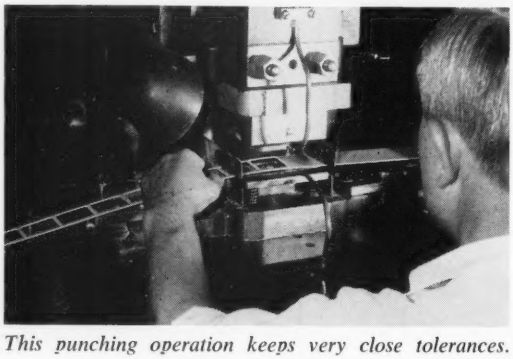
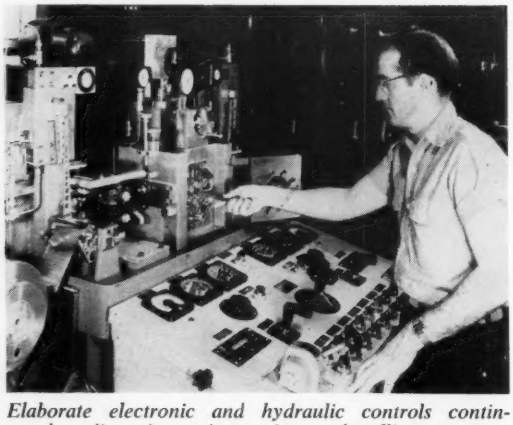


Plate with an assembled miniature precision switch.



This punching operation keeps very close tolerances.

Ultra-thin strip in a wide range of metals



Elaborate electronic and hydraulic controls continuously adjust for strip tension and rolling pressure.

Ultra-thin metal strip held to exceptionally close thickness tolerances is now being produced by the Allied Products Division of Hamilton Watch Co. This strip is now available in widths up to 4 in., and in thicknesses from 0.010 in down to 0.00012 in., with the thickness guaranteed as uniform to a tolerance of 0.00005 in. In addition, Hamilton's facilities and techniques for rolling this strip insure a high degree of uniformity in thickness (freedom from camber) across the width of the strip.

This cold-rolled, ultra-thin, precision gauge strip is possible in a wide range of metals, from the very hard high-temperature resistant alloys down to the very soft light metals.

The strip is produced in Hamilton's miniature integrated steel mill, a facility staffed and equipped to melt almost any alloy, or to produce almost any desired metal processing.

The company will roll the ultra-thin precision strip

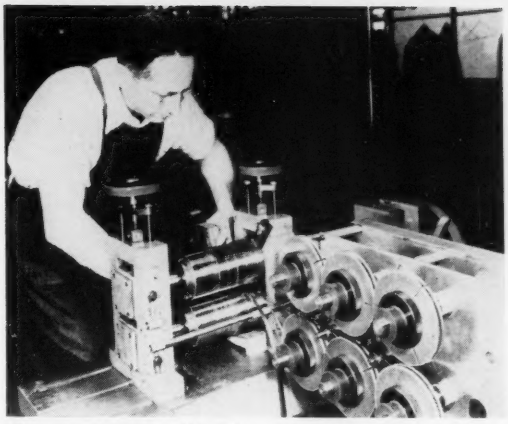
from metal furnished by the customer or will produce (melt, cast, forge and hot roll) the metal for it to the customer's specification. Furthermore, the Allied Products Division will slip this ultra-thin strip to smaller widths with closer tolerances than are commercially available, that is, in ribbons as narrow as 0.04 in. with widths held to a tolerance of ±0.001 in. This slitting is done on special machines of Hamilton's own design. These not only allow slitting narrow widths to such close tolerances, but also ensure clean-cut edges free from ripple.

This ultra-thin precision gauge metal strip has already been produced to meet special needs in the automatic control, electronics and atomic energy fields.

The strip is particularly suitable:

(1) Where exact thickness and precise metallurgical properties of thin metal discs (diaphragms) are required to ensure accurate calibration and freedom from hysteresis in instruments or control devices. For example, in air-operated valve positioners or air relays.

(2) In high-speed production processes using thin metal strip raw materials, where the strip's close-tolerance dimensions and as-specified metallurgical properties ensure easy stamping and a low percentage of rejects. Light-gauge metal springs, laminated shims and feeler gauges are examples.



This equipment slits the extra-thin metal ribbons.

(3) In the manufacture of tape-wound magnetic cores or sheaths, where precise thickness and metallurgical properties of the tape are required to produce desired electrical or magnetic performance characteristics. Instances are: computer memory cores, magnetic delay lines and distributed-constant electrical components. (226)

This tubing stands high temperature and pressure

Production is announced by Haveg Industries, Inc. of Teflon pipe and tubing and lined steel pipe.

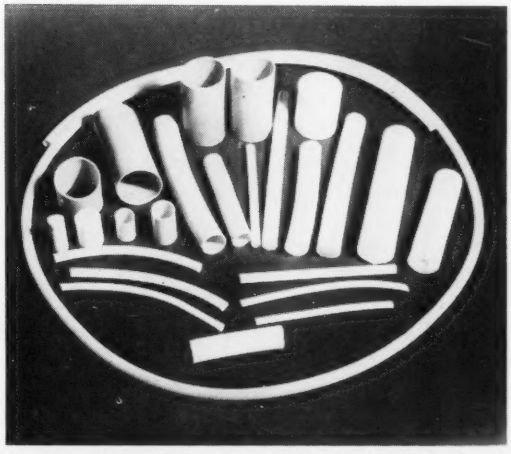
Teflon, the Du Pont trade name for tetrafluoroethylene resin, has a combination of electrical, chemical and thermal properties unmatched by any other single material. It is completely inert to practically all chemicals. It has no known solvent and is attacked only by molten alkali metals and fluorine at elevated temperatures and pressures. It is completely resistant to nitric, hydrochloric, sulphuric, hydrofluoric and hydrobromic acids and is unaffected also by highly oxidizing compounds such as aqua regia and sulphur or chlorine dioxides.

The material remains tough and flexible over a wide range of temperature. It is resistant to abrasion and thermal shock, and will withstand 150 psi over a wide range of temperatures even below —90F, and is capable of continuous service to 500F. A reinforced structure of steel pipe lined with Teflon makes for even greater resistance to shock and vibration, the lifespan of Teflon itself being practically unlimited.

Dielectric properties (such as high dielectric strength, low power factor and dielectric constant) are excellent over a wide range of temperature and frequency. Its electrical properties are essentially unchanged at temperatures up to at least 400F, qualities which make it one of the best electrical insulators in the world.

The pipe, tubing, rods and Teflon-lined steel pipe being produced by Haveg can be cut to the desired length in the field and readily flanged.

An outstanding property is its low friction characteristics—few materials tend to stick to its surface. This property makes it valuable in the handling of sticky materials, particularly bread dough or candy. Teflon may even be used to replace stainless steel and other plastic materials in applications where there is a danger of food contamination and also need for a nonsticky surface.



Samples of the Teflon pipe, tubing and rod produced.

This nonflammable resin is unaffected by outdoor weathering. Samples exposed in Florida for ten years were completely unchanged.

Insulation made of it can stand the effects of sunlight and rain without any deterioration in operating properties. It has zero moisture-absorption as measured by ASTM tests.

Besides its many obvious electrical applications, this fluorocarbon tubing is primarily designed for use at high temperature and pressure with steam or corrosion fluids and chemicals. (227)

Continued over page ▸

Pinhead thermistors with an accuracy of 0.001°C

Full-scale production of precision thermistors is now under way at Fenwal Electronics who enter the field at a time when there is great interest in commercial applications for the thermistor, once little more than a laboratory curiosity.

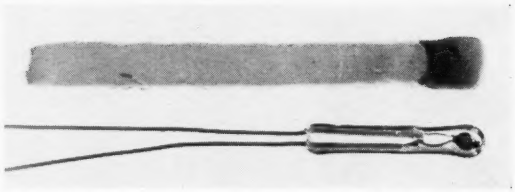
The elements will be available in all standard forms —rods, discs, washers and uncoated or glass-coated beads. Also offered is an engineering and design service to develop circuits and tailor thermistors to specific applications.

Thermistors are, of course, semiconductors made by fusing the oxides of such metals as nickel, manganese, cobalt and uranium, into a hard, dense ceramic-like material.

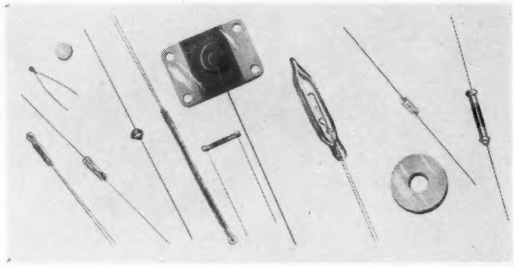
The name thermistor, a contraction of "thermal resistor," describes one of the element's important characteristics: that its electrical resistance changes with temperature. Although many semiconductors and metals have this property, their change in resistance with temperature is comparatively small. For example, the specific resistance of a thermistor material changes by a factor of 1,000 to 1,000,000, while the resistance of platinum, a commonly used temperature-sensitive element, changes by a factor of less than 10 over the same temperature range. This extraordinary sensitivity means that the thermistor responds to extremely small temperature changes; it can therefore be used to measure temperature with an accuracy of 0.001C. For standard industrial applications, temperature controllers using a thermistor sensing element, such as Fenwal's Series 560 instrument, have been developed to control temperature within 1F.

Other advantages of the thermistor are its small size (some are as small as a pin-head) and the fact that, because of its exceptionally high sensitivity, the sensing element can be located 200 ft or more from the controller, with little or no reduction in the working signal.

Another property, its current-voltage characteristic, has led to a number of interesting and far-reaching applications. When a thermistor is used in an electrical circuit and the current is allowed to exceed a certain value, the voltage through the thermistor is no longer proportional to the current, but drops off with further increase in current. This makes the thermistor very useful for applications involving automatic voltage regulation amplifier gain control, temperature alarms, contact-less switching action and so forth.



This photo emphasizes the small size of the bead-type thermistor, one of the many forms produced by Fenwal.



Some of the many shapes. Shown are beads, rods, discs, washers and one unit assembled to a mounting plate.

Since this voltage drop-off is a function of the decreased resistance of the thermistor due to self-heating, applications can be based on the amount of heat that the thermistor can dissipate to its environment. This opens up a new technique of instrumentation for the detection or measurement of fluid flow, liquid level, thermal conductivity and other variables which produce cooling or heating around the sensing element.

The third important property is the current-time characteristic. Depending on the material, a thermistor will require from a few milliseconds to several minutes before the current through it reaches its final level. Using a thermistor with the appropriate time delay provides a simple means, therefore, of designing equipment requiring specific time delays without complex circuits or costly equipment.

Such an application has eliminated a problem of false ring-ups in telephone circuitry caused by transient disturbances. A thermistor placed in series with the ring-up relay will delay operation of the relay for a period long enough to screen the transient signals. (228)

Testing tube, wire, bar and rod

A new and completely automatic Magnatest FW-400 inspection unit for nonmagnetic rod, wire, tube and bar can be obtained from the Magnaflux Corporation. The instrument automatically inspects such things as seams, overlapping, diameter changes, inclusions, voids, concentrated porosity, metallurgical variation and splits. It is ideally suited for high-speed plant operation and is the first of a new line of electronic nondestructive testing equipment made by Magnaflux Corporation.

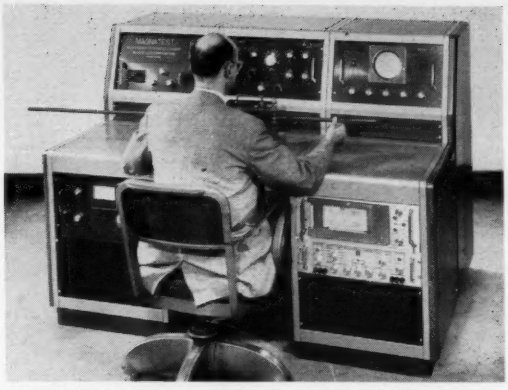
The FW-400 itself is a series of instruments designed to cover the whole range of nonmagnetic materials from aluminum, brass and copper to tungsten, austenitic stainless and titanium in a range of diameters from 1/64 in. to 3 in. The units are designed for either completely automatic, high-speed operation on production lines or hand operation in laboratories.

Units already in operation show the great need which exists. Positive location of seams, embrittled areas and diameter variation in the tungsten wire used in vacuum tubes is one that has shown its value. Copper and brass tubing of all types is being inspected automatically with the new instrument. Often a cumbersome, and not too reliable, hydrostatic test is eliminated. Inspection of aluminum rod for voids and inclusions prior to wire drawing is another area where the instrument is valuable.

A typical FW-400 unit can be operated at production speeds in excess of 150 to 300 fpm. Such a unit would be operated without any personnel. It could be equipped with automatic signaling and recording devices, and works equally well on cut or continuous lengths.

The new Magnatest series is designed so that either absolute or differential types of test can be made. The absolute tests are used whenever there are changes, such as in hardness or alloy content. The differential type tests are more common. They negate gradual changes and find only abrupt defects such as seams and lapping.

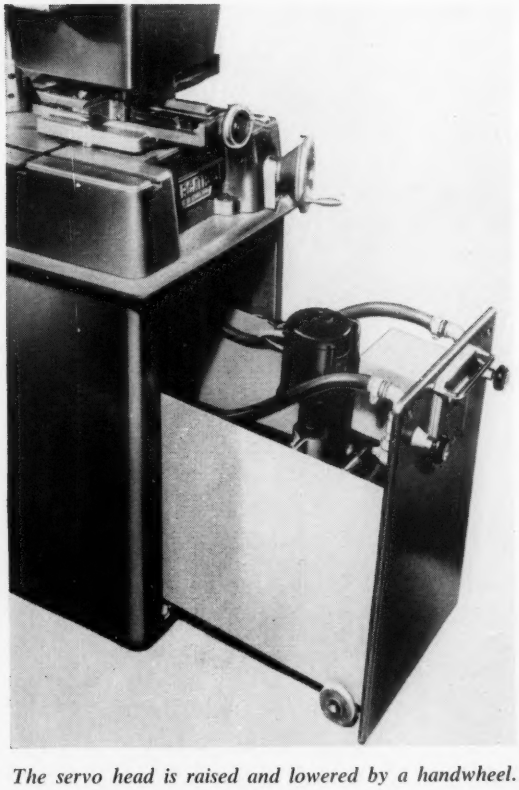
Three different models of the FW-400 series units have been designed. Each one can be equipped with both types of coil in the full range of sizes, the automatic features and all test frequencies. The three models consist of a vertical floor mount, best suited for permanent production facilities; a console which accommodates several different units and designed for the maximum flexibility required in research facilities; and a table model which is generally best suited for intermittent usage on a limited number of different materials or sizes.



This FW-400 console model is made for laboratory use.

The Magnatest FW-400 Series will open new fields to nondestructive testing for it makes possible the inspection of nonmagnetic rod, tube and wire with complete reliability and more economically. (229)

Hard metals can be machined by blasting with a spark



The servo head is raised and lowered by a handwheel.

A new and much improved Sparcatron Mark III electro erosion machine is now available in Canada.

Sparcatron is a method of machining by means of an electric spark, a process that presents vast opportunities to production engineers. The process provides a means of working hard metals that cannot be machined by edge tools or even be readily ground by abrasive wheels. Basically, the idea is that the enormous energy contained in an electric spark is used to blast away particles of the metal as it strikes the workpiece. It is a practical and economical method of applying and controlling the spark erosion with great accuracy.

The key-note in the design of the 6.5 kw Mark III equipment is its simplicity and ease of operation, added to which the equipment has an exceptional degree of accuracy and cutting speed. The new model is, in fact, capable of operating from three to eight times as fast as previous machines, depending on the type of material and finish required.

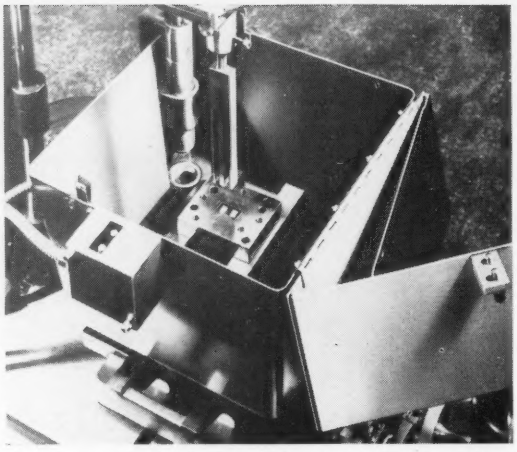
Maintenance of both the electrical and mechanical sections of the machines have been reduced to a minimum and all valves have been eliminated from the servo control in the main control and auxiliary control cabinets.

Due to the new electrical circuit and the new servo motor control, the machine is stable in operation and requires no skilled adjustment by the operator. For ease of operation, the servo head is now raised and lowered by a handwheel, conveniently situated to the operator's right hand, and that popular feature of previous models is retained whereby the servo head can be swung aside to allow for the easy handling of heavy dies. The well-known servo head, in which the ram

Continued over page ▸

is positioned between two sets of balls operating in V-slides to ensure perfect accuracy, now has a neat and accurate stroke limit switch. This can be set quickly so that the current is automatically cut off when the electrode has penetrated the workpiece to a predetermined depth.

The design throughout is rigid and robust, the main column for the servo head being of 5-in. diameter. The sleeve of the bracket supporting the head is 10 in. long, whilst the base on which the compound table is fitted is heavily webbed and capable of carrying a weight of over 500 lb. The table tank has been increased in size to allow easier positioning of dies, and the settling tank in the base of the cabinet has been increased in capacity and incorporates a special arrangement of baffles to prevent debris from the machining operation being recirculated through the pump. The mechanical section of the Mark III model is produced to well within Slessinger limits for similar types of machine, all working faces being ground and scraped where desirable. (230)



Maintenance of both electrical and mechanical sections of the machines has been reduced to the very minimum.

This beefy skin mill will help turn out the CF-105

In regular operation now at Avro Aircraft is a 200-ton skin-milling machine, the biggest of a battery of new machines lined up for the production program of the supersonic CF-105.

The only one of its kind in Canada, and by far the most versatile in its field, the new mill is capable of carrying out any of the skin-milling work likely to be necessary in the foreseeable future.

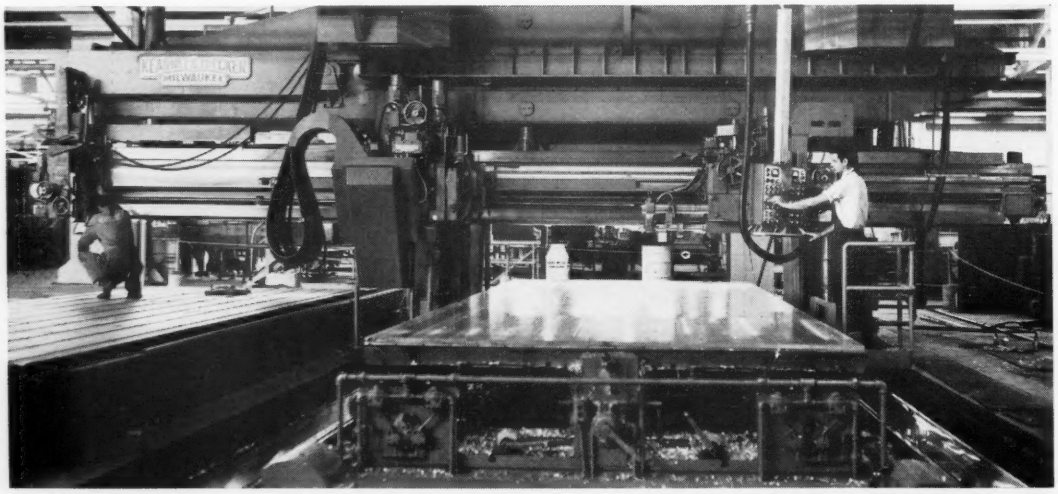
In these days of supersonic flight, the skin mill, which machines complete sections of a wing skin and its stringers out of solid metal, has become increasingly important.

By the side of the 28-ft-by-9-ft work table of the Avro mill is another table on which the template is placed. A stylus is guided by the operator along the contours of the template. This stylus (under pressure) transmits its readings to an electronic centre which sends out the pattern to the large traveling head of the machine.

As the 70-ton head and gantry starts to move, the tool attached to it begins to trace the same pattern in a solid billet of aluminum, ripping the chips out at high speed. For example, during recent test runs a tool taking a cut 2¾ in. wide by 1¾ in. deep cut through the metal at about 9 fpm.

To keep the tool cool while running at this speed, a flood coolant system provides 75 gpm.

On a typical skin job, the machine will start with



A stylus is guided along the template and, under pressure, transmits the pattern to the traveling head.

a 3,300-lb billet of aluminum and end up with a finished product of less than 300 lb, having milled out over 90% by weight in the form of chips.

To keep the machine from burying itself in these chips, they are fed to a conveyor belt, which in turn feeds them into mobile scrap bins.

The large slabs of aluminum are held in position on the work table by vacuum and the tool can be tilted and swiveled to facilitate the cutting of tapered skins and converging ribs. There are 30 motors in various parts of the machine.

The mill is also equipped with automatic safety devices. If the vacuum holding the work drops below a certain value, the tool stops cutting and retracts. The same thing happens if the tool begins to overheat. To prevent a tool from cutting too deeply (and into the harder metal of the work table) a 2-in. slab of aluminum is permanently fitted over the whole table area for the work to rest on.

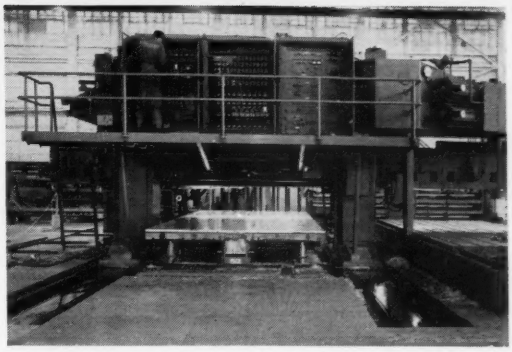
The first cutting job for the mill was to take a fine shaving off the whole of this aluminum slab to ensure its complete alignment with the traveling head.

The machine was built by Kearney and Trecker to Avro Aircraft specifications and because Avro pioneered in this field the cost was $350,000.

It cost Kearney and Trecker over $1,000,000 to design and construct the first model. Today's price for the same model is $600,000.

The mill, the biggest ever made by Kearney and Trecker, is constructed in such a way that, if required, extra sections can be bolted to the ends of the work and template tables to increase the working area.

The basic speed of the gantry is 30 in. a minute. On straight through cuts, with rise and fall tracer control, up to 100 in. a minute is possible. For conventional milling cuts, longitudinal feeds and cross feeds, speeds up to 160 in. a minute are possible. Rapid traverse for positioning can be carried out at 240 in. a minute.



The aluminum slabs are held in place by vacuum. The tool is able to cut tapered skins and converging ribs.

Both heads are dual speed — 50 hp at 1,300 rpm and 100 hp at 3,600 rpm. The chuck will tilt ±2 deg longitudinally or transversely and will swivel 5 deg to each side of centre in the horizontal plane.

There is provision for automatic indexing of both the cutting head to the next cut and the pick-up stylus to the next template. Both the vertical and the horizontal heads have automatic power clamping. The mill has renewable and replaceable way surfaces on the beds and on the gantry shoes. There are 150 yds of reinforced concrete in the mill foundations which were made in one integral pour.

Distance between hole centres measured automatically

Inspectors can now measure the distance between hole centres quickly and accurately without knowing diameters and without any mental figuring or pencil work.

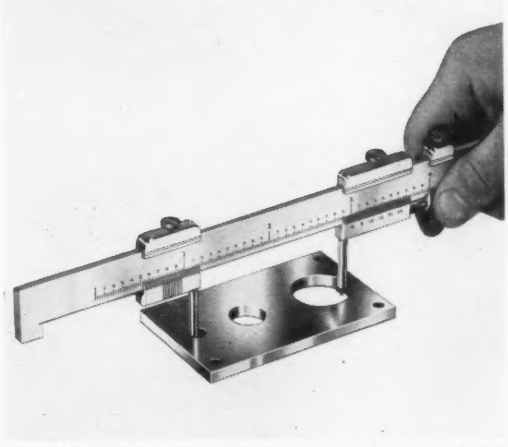
A newly developed gauge, the Centre-Mike, produces a direct reading of the centre-distance. It requires no setup and is always ready for use on any combination of hole diameters within its range.

The instrument is basically a vernier gauge and a slide rule combined. In operation it is first set to the closest points on the two holes and is then reset to the farthest points on the same holes. While the operator makes these settings, the two lengths are automatically registered and their average value computed by the Centre-Mike. This value, the centre-distance, appears on a double-size vernier scale.

The operating sequence employs a compensating principle that reduces the effect of differences in feel between operators.

The gauge can also be used for measuring the distance from a hole centre to a parallel surface.

There are three sizes, for maximum centre-distances of 4.400 in., 7.400 in. and 12.400 in. respectively. All of them will measure centre-distances ranging upward from 0.240 in. to their respective maxima. All sizes are usable for any combination of holes when both are larger than 0.200-in. diameter. Optional supplementary contacts will extend the range downward to 0.061-in. diameter. Work contacts are of tungsten-carbide and the scales are machine graduated.



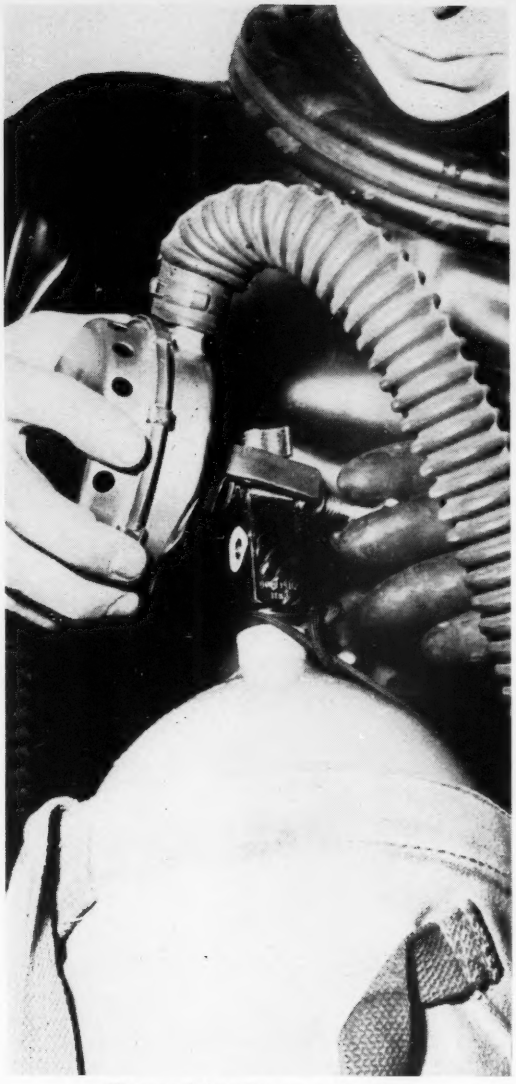
The work contacts on the new Centre-Mike are of Tungsten-carbide and all the scales are machine graduated.

Standard equipment includes a hardened and ground centre-distance standard and a wooden case. (231)

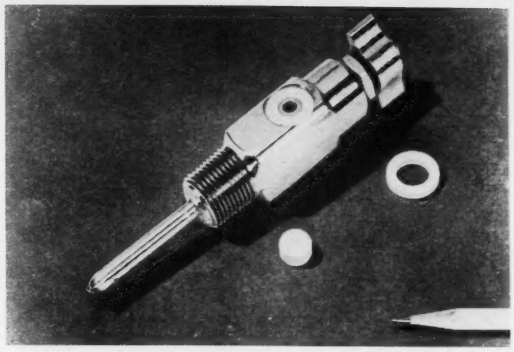
A skin diver submerging with his underwater breathing equipment.

Valves that the skin-diver can trust

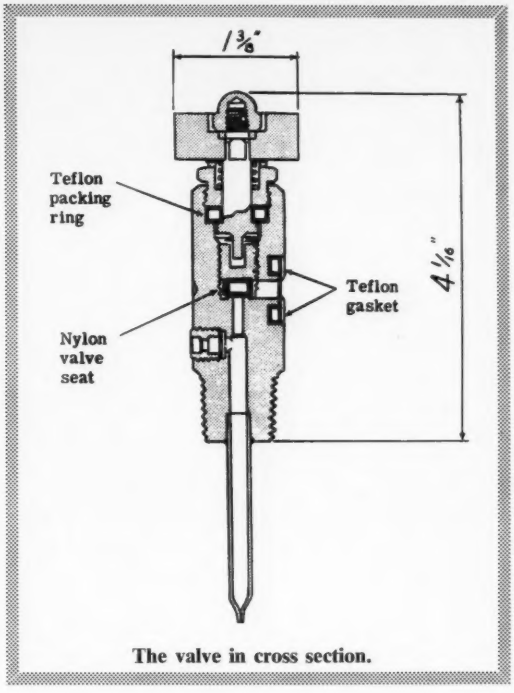
One of the youngest water sports is skin-diving which traces its origin to wartime frogmen. New valves have cut the risk of air supply failure



The regulator slips over the valve.



Gasket, packing ring and seat are all Teflon or nylon.



The valve in cross section.

A growing sport that owes much to the last war for its development is a hand-down from the Navy's saboteur frogmen—skin diving. The growth in the range of equipment for the man who seeks his recreation underwater has been rapid and great progress has been made in valve design.

Three non-metallic parts have keyed the design of a new air cylinder valve engineered for reliability, long life and easy handling with skin diving equipment.

Meeting some highly specialized problems in the performance of this valve are a Teflon packing ring, a nylon valve seat, and a Teflon gasket.

All three are fabricated economically in large quantities and supplied by Polypenco Inc. They are machined to exact engineering specifications on automatic screw machines from the company's own Polypenco Nylon and Teflon bar stock.

The valve in which the three parts are used must positively open or close to regulate the air from the compressed air cylinder into the pressure regulator unit.

The three Teflon and nylon parts are vital to the constant and reliable flow of air into the swimmer's lungs. Each serves a different purpose specifically suited to its inherent properties and characteristics.

Nylon is used as the valve seat in this assembly because of its excellent sealing characteristics and wear resistance. These properties permit repeated opening and closing of the valve, even at 2,500 psi cylinder pressure. The valve is fully operated by turning the wing nut operating wheel one revolution or less. Also important to this application is the natural resilience of the nylon. When the load or pressure is removed, the nylon will spring back to its original shape.

The horizontal Teflon packing ring seals the upper stem into the body of the valve. Teflon is used here because of its low coefficient of friction and excellent sealing characteristics. An external Teflon gasket surrounds the outlet port, permitting a positive and easily operated seal between the outlet yoke and the valve body itself. It flows under pressure until it is tightly secured. ★

Make sure you know the "inside story"

Our author's premise is that too many electric motors are purchased today without due consideration being given to their internal design

By C. D. Hall

BEPCO CANADA LTD.

A large number of electric motors are purchased today without a great deal of consideration being given to the type of design of the internals. Most motor manufacturers produce a motor that looks trim and has a certain amount of eye appeal, but the life and performance of the motor depend on vital parts contained inside the machine and not readily seen. In this article the common types of modern stator winding will be compared in order to help the reader assess the relative merits of the various designs of present-day motor.

The stator winding is generally considered to be the most vulnerable part of the squirrel cage and wound rotor type of motor because it is connected directly to the supply source. The windings have to be insulated from the laminations and the frame, which act as the "ground." They also have to be insulated between each other and particularly between the different phases.

There are several types of winding and a comparison between a few of the most common reveals some very interesting points for consideration. Practically all stators are wound with either one coil per slot or two half coil sides per slot. The one-coil-side-per-slot winding is used with "group" fig. 1), "basket" (fig. 2) or "concentric" windings (fig. 3) and the two-half-coil-sides-per-slot winding is commonly called a "lattice" (fig 4).

Figures 1, 2, 3, 4 show a completely developed winding for a 36 slot stator wound for 4 pole. Figures 1a, 2a, 3a, and 4a show how the coils look before being placed into the stator frame and figures 1b, 2b, 3b and 4b show the appearance of the stator winding when wound with one of these four types. Now compare figures 5 and 6. Fig. 5 shows a cross section of a stator slot containing a coil side, of a one-coil-per-slot type of winding as used with the windings illustrated in figures 1, 2 and 3. Note that, in this case, it is only necessary

A comparison of the types of winding reveals some interesting points

Type of Winding	Illustrated in:	Slot sections with two opposite phases	Opposite phase crossovers in end windings	Total number of phase-to-phase points of contact.
GROUP	Fig. 1	0	108	108
BASKET	Fig. 2	0	108	108
CONCENTRIC	Fig. 3	0	216	216
LATTICE	Fig. 4	24	360	384

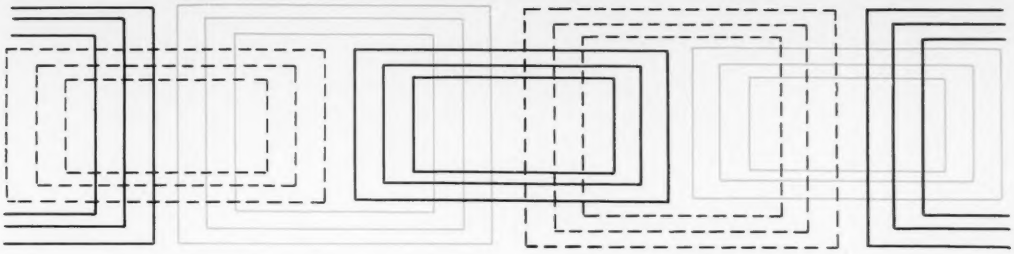


Fig. 1. Diagram of a completely developed 36 slot, 4 pole group winding.

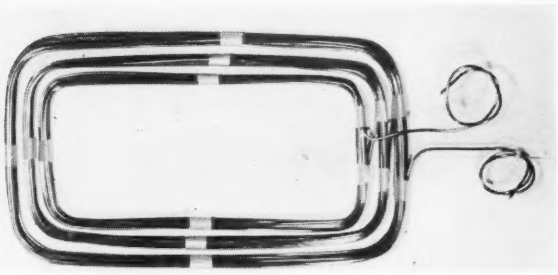


Fig. 1a. Stator coils ready for winding. Series connections are formed by continuous winding from one step to another.

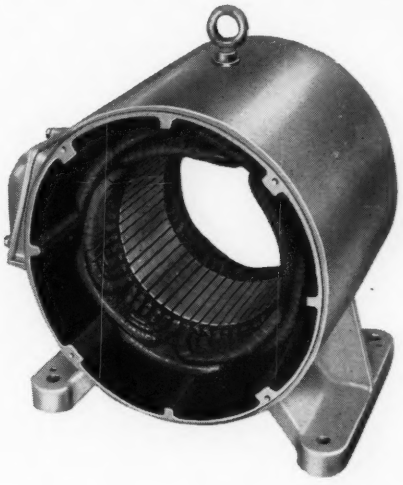


Fig. 1b. Completely wound stator. The taped coils are not generally necessary. They provide extra protection.

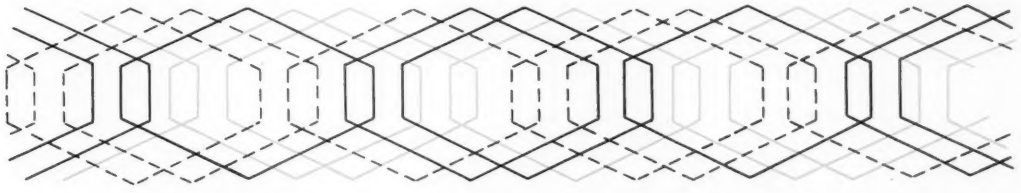


Fig. 2. Diagram of a completely developed 36 slot, 4 pole basket winding.

Fig. 2a. (left) Stator coils ready for winding. The leads have been brought out in this case.

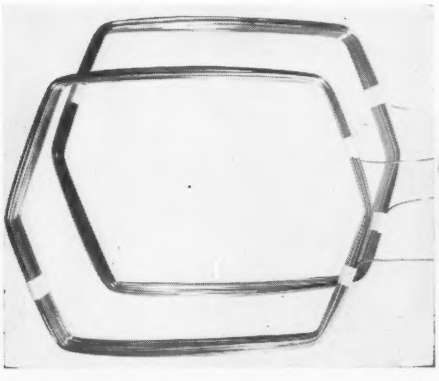


Fig. 2b. (right) The completely wound stator. Taped coils are for extra protection only.

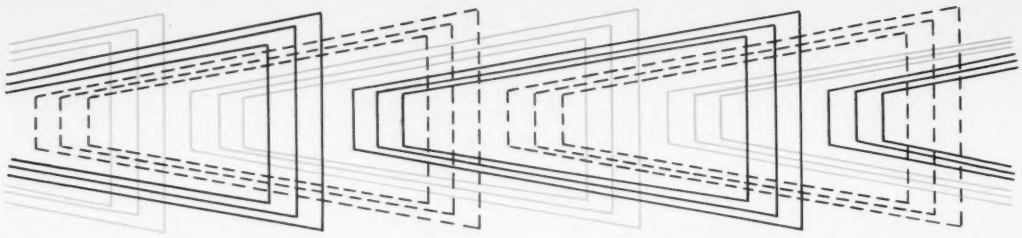


Fig. 3. Diagram of a completely developed 36 slot, 4 pole concentric winding.

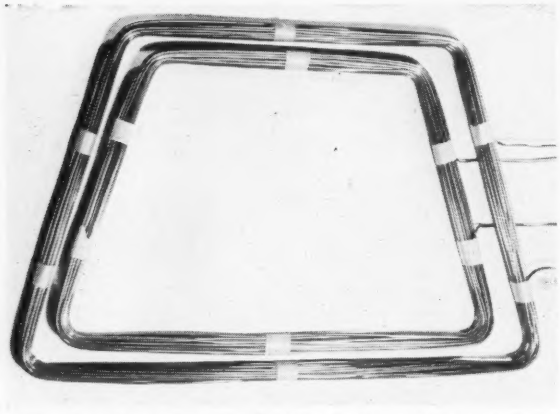


Fig. 3a. Stator coil ready for winding. Series windings are made by continuing winding in coil winding operation.

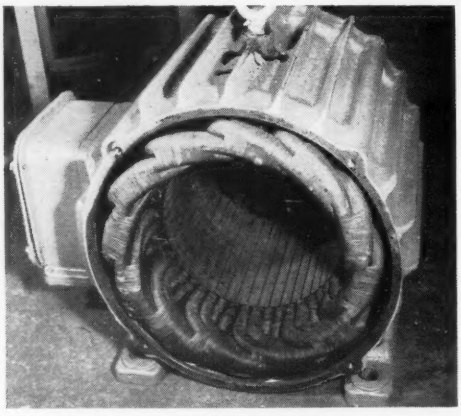


Fig. 3b. The completely wound stator. The taped coils provide extra protection in special cases.

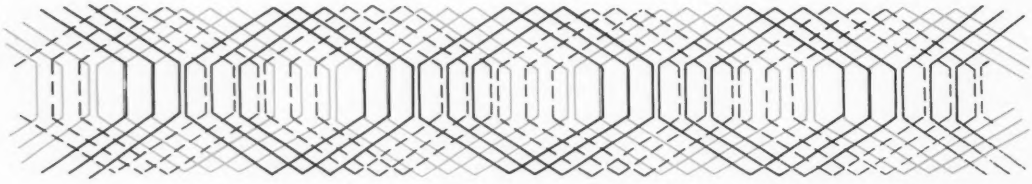


Fig. 4. Diagram of a completely developed 36 slot, 4 pole lattice winding.

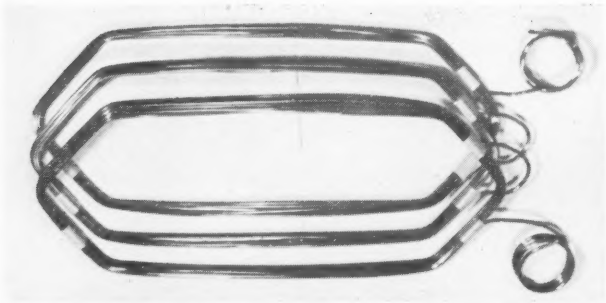
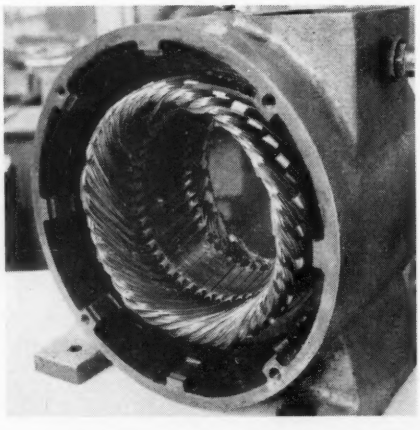


Fig. 4a. (above) Stator coils ready for winding. Series connections are made by continuous winding from one step to another.

Fig. 4b. (right) The small range lattice-wound type of stator.



to insulate between the coils and ground, which is the stator iron. Fig. 6 shows the stator slot containing two half coil sides per slot as used with the windings illustrated in fig 4. Note that the same insulation to ground is necessary and that, in addition, it is necessary to insulate between the two half coil sides. On a 3 phase supply, the voltage to ground is less than line voltage and this condition applies to both types of winding so far as ground insulation is concerned. In the case of fig. 6, where two half coil sides are fitted into the slot, it is necessary in addition to insulate between the two half coils. The maximum voltage between coils at this point, in a good percentage of the total winding, is at line voltage or approximately so.

From the above it can readily be seen how the manufacturers of motors, using the types of winding illustrated in figures 1, 2 and 3, have designed their windings to do away with two opposite phases in the same slot (as exists in the lattice type winding) and have therefore removed a potential danger point where a large proportion of breakdowns do occur.

The one-coil-side-per-slot type of winding has this advantage over the two-half-coil-sides-per-slot type. The possibility of a breakdown between phases in the slot is eliminated, because the winding is designed specifically for only one coil. The elimination of this possible cause of breakdown does a great deal to keep the motor operating longer.

The difference in the slot section, as described above, is only half the story. A study of figures 1, 2, 3 and 4 reveals that the coils cross over at certain points throughout the entire winding, but in addition, also lie alongside each other in various patterns.

There are certain factors pertinent to all styles of winding, such as: the magnet wire insulation must be adequate to withstand the voltage between adjacent turns; the outer covering of the coil must be insulated to withstand the voltage present between coils in the same phase; and phase insulation must be included to protect one phase coil against another. Ground insulation must be provided in the slot. The various types of winding demand their own quantity of insulating. It is necessary thoroughly to insulate between phases whether it is in the slot section or in the end windings. A lot of failures occur between phases in the slot and the same applies to the end windings. It seems logical to design a winding with the least number of points where one phase coil crosses (or comes in contact with) an opposite phase coil. This will automatically produce a stator winding with the least chance of breakdown.

It can be seen that figures 1 and 2 have 54 points where one phase coil crosses an opposite phase coil, on each side of the winding thus making a total of 108. Fig. 3 has 108 similar points on each side, with a total of 216, whereas fig. 4 has 180 similar points with a total of 360.

From a study of these windings it can be seen that group, basket and concentric windings are in a very favorable position relative to the lattice winding.

The one-coil-side-per-slot type of winding not only has advantages over the lattice type in respect to the slot portion, but is considerably better so far as the end windings are concerned.

The fact that group, basket and concentric windings have far less crossovers enables the winding to be installed with less volume of phase insulation and allows better ventilation throughout the winding. A lattice type on the other hand, has to use a lot more insulation for satisfactory insulation between phases, with the result that the winding is more closely packed and ventilation through the winding suffers. This is particularly so in smaller motors.

It is interesting to note that, while the modern motor of today is far superior to the machines manufactured at the beginning of the century, the general appearance of the conventional stator has remained practically unchanged for many years. The main developments have been in varying the types of enclosure, and in the types of material available, many of which have been specially developed to meet the growing demand for motors that are smaller and lighter, but considerably more efficient than their predecessors.★

Good motor performance is more than the eye-appeal of a trim casing."

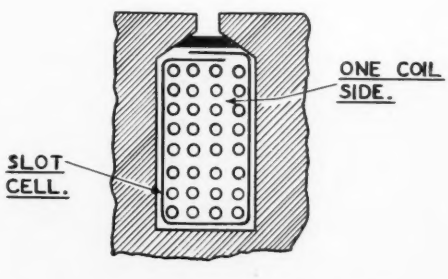


Fig. 5. Group, basket and concentric windings all have a one coil per side slot arrangement.

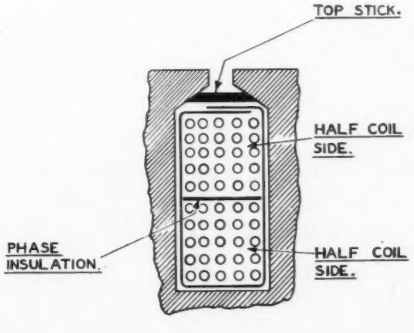


Fig. 6. Lattice windings have two half coil sides per slot. Note the phase insulation.

New material

Do you know the newest super steels?

"There is no doubt that high-strength steels will continue in importance. We can only speculate on what their maximum strength could be."

By H. P. Tardif

C.A.R.D.E.

In the last ten or fifteen years the need for new metallic materials has been enormous. Metals practically unheard of — such as germanium, thorium and plutonium — have suddenly come to light to take their place in the electronic or atomic industry. High temperature alloys for power plants have been developed that will stand up to the drastic conditions of oxidation or erosion encountered at high temperatures. Ferromagnetic materials are being produced with such properties that the efficiency of electrical devices is greatly improved. In the field of constructional steels progress has also been rapid in many directions, not only with the low alloy steels but especially with the new ultra-high-strength steels.

The demand for steels of very high tensile strength has been prompted by the use in the aircraft industry of aluminum alloys (75S) of 70,000 psi tensile strength. In order to compete with this material, the three-times-heavier-than-aluminum steel would have to be used at the 210,000 psi level. This is possible with 4340 but unfortunately the impact and ductility properties of the steel when heat-treated in the standard manner are too low. A requirement was then obvious for a steel of 210,000 to 230,000 psi tensile strength, with impact properties as good as those of the flight and time tested 4340 when heat-treated in the '80,000 psi strength range. These requirements were met by many steels but the need soon arose for steels in the 300,000 psi range with reasonable impact.

Not only in the aircraft industry are steels of this type required. The high strength-to-weight ratio of steels heat-treated in the tensile range 200,000 to 300,000 psi (and possibly above) would permit a reduced weight and/or a saving in space, two requirements often necessary in the design of modern machines. Applications of the future might be found in transportation equipment such as trucks, in lightweight railroad cars for high-speed trains and for objects that must be frequently transported. But perhaps there is no other field where reduction in weight and saving of space are so desirable as in the ordnance field. Tactical requirements often entail a limitation of the weight of various machines; lighter infantry weapons would decrease the burden and increase the efficiency of the infantryman; airborne army equipment such as guns, tanks and jeeps could be moved more cheaply. Steels of higher strength would permit considerable weight saving in most types of military equipment, with consequent advantages.

Two approaches have been followed in the search for steels of this type:

(1) Evaluation of the properties of existing high-alloy constructional steels when heat-treated at high strength levels and studies of the effect of processing variables on them;

(2) Development of new compositions.

Concurrently with the development of new high-strength steels by steel producers, active research and test programs were initiated to evaluate the properties and limitations of some already existing constructional steels.

The effects of grain size, slack quenching structure at the base of the notch, total reduction from ingot to finish size and other processing variables were all taken into account in studies of mechanical properties in the static and impact notch bar tests. Investigations in the U. S. by Lockheed Aircraft Corporation and Chance Vought Aircraft Inc. showed that 4340 heat-treated to 260,000 or 280,000 psi is suitable as an aircraft material, provided certain precautions are taken. In England a study made at William Jessop and Sons, Ltd. showed that the Standard En 24 steel met the following properties required by an aircraft manufacturer:

UTS.	= 264,000 psi
0.1% Proof stress	= 187,000 psi
Elongation	= 6% on 2 in.
Izod impact	= 20 ft lb

The ultra-high strength steels recently developed can be described as modified medium-carbon, triple alloy steels. Many papers of a general nature have already been published on this subject and the main principles followed in determining a suitable composition are as follows:

(a) The best combination of strength and impact properties is only obtained by tempering a completely martensitic structure. The alloy content must there-

Table 1: Composition of Typical Ultra-High Strength Steels

	Material	Carbon	Manganese	Silicon	Cromium	Nickel	Molybdenum	Vanadium
	S.A.E.4340 (a)	0.40	0.65	0.30	0.80	1.80	0.25	....
	S.A.E.4360 (a)	0.60	0.65	0.30	0.80	1.80	0.25	....
Crucible Steel Co. of America	Hy-Tuf	0.25	1.35	1.50	0.25	1.80	0.40	....
	Super Hy-Tuf	0.40	1.30	2.30	1.40	....	0.35	0.20
	Hi C Super Hy-Tuf	0.47	1.28	1.85	1.11	....	0.42	0.25
United States Steel Co.	B-514 (b)	0.25	0.80	0.60	0.70	2.30	0.55	....
	B-1311 (c)	0.35	0.90	0.71	0.83	0.88	0.55	....
	98BV40 Mod. (d)	0.40	0.85	0.70	0.75	0.80	0.50	0.06
Republic Steel Corp.	S.A.E.4330 Mod.	0.30	0.90	0.30	0.85	1.80	0.45	0.10
	Super TN-2	0.40	0.85	0.60	1.45	2.20	0.50	....
	Cr-Ni-Mo-V Type 2	0.30	0.90	....	0.75	1.85	0.45	0.10
Timken Steel and Tube Co.	H.S. 220	0.30	0.70	0.60	1.20	2.05	0.45	....
	H.S. 260	0.40	0.85	0.60	1.45	2.20	0.50	....
International Nickel Co.	Base Composition(e)	0.40	0.70	1.60	0.90	1.90	0.45	0.07
	Tricent	0.43	0.80	1.60	0.85	1.83	0.38	0.08
	Super Tricent	0.55	0.80	2.10	0.90	3.60	0.50	....
British Standard Steels	En 24 (S 95) (a)	0.39	0.68	0.27	1.05	1.40	0.23	....
	En 25 (S 96) (a)	0.27	0.65	0.18	0.62	2.70	0.64	....
	En 27 (S 65) (a)	0.31	0.51	0.14	1.26	3.21	0.40	....
	En 3073 (3S.28) (a)	0.33	0.61	0.27	1.46	4.27	0.31	....
	En 40C (a)	0.34	0.68	0.15	3.20	0.64	0.89	0.24
William Jessop	Cast No. 4824	0.40	1.08	1.61	1.49	0.64	0.51	0.27
	Cast No. 4828	0.26	0.64	1.87	1.17	2.90	0.47	....

(a) Conventional Steel (b) 0.70% Copper (c) 0.0039% Boron (d) 0.0015% Boron (e) 0.08% Aluminum

"Even in super steels, prestressing may increase their performance."

fore be properly adjusted so that the resulting structure is fully martensitic.

(b) Notch impact is inversely proportional to carbon content which should consequently be as low as possible for the strength level desired.

(c) Elements that "retard" tempering, such as silicon, should be added in order to raise the peak in the impact tempering curve to the highest possible temperature.

The first of the new series of high strength, high notch ductility steels (Hy-Tuf) was developed by Crucible Steel Co. and described by Nehrenberg and Payson. Comprehensive testing programs have been carried out by different laboratories to evaluate and compare the notch impact, notch tensile and notch fatigue properties of Hy-Tuf with those of other constructional steels at a tensile strength of about 235,000 psi. It was found that, at a given high tensile strength level, this steel had a better impact resistance and less sensitivity to notch effects in the static tensile and rotating beam fatigue tests than conventional steels. Many other testing programs were also carried out on this steel.

Another high strength, high toughness steel has been developed by Republic Steel Corporation and can be described as a modified SAE 4330 (increase in molybdenum) to which vanadium was added. When heat treated at a tensile strength of 170,000 psi the ductility of this steel, as measured by elongation and reduction of area, compared favorably with that of Hy-Tuf and 4340 treated at the same strength level. At the 220,000 psi strength level, however, the impact was less than that of Hy-Tuf but better than that of 4340. Many other comparative studies have also been made.

The steps involved in the development of ultra high strength steels in the U. S. has been fully described elsewhere. In other countries, however, the work caried out in this field is not so well known. Some of the work already done in England on the subject has

Table 2: Optimum Mechanical Properties

Material	Treatment	0.2% proof stress (psi)	Tensile strength (psi)	Elong. % on 2 in.	Reduct. in area %	Izod Impact (ft lb) at 70F.
SAE 4340	O.Q.1500F. T.920F.	180.000	190,000	15	49	30
	O.Q.1500F. T.650F.	212,000	236,000	10	35	15
	O.Q.1500F. T.450F.	222,000	270,000	10	35	14
Hy-Tuf	O.Q.1600F. T.550F.	190,000	230,000	13	49	30
Super Hy-Tuf	O.Q.1700F. T.550F.	241,000	294,000	10	35	14
Hi C Super Hy-Tuf	O.Q.1700F. T.550F.	.....	325,000	..	24	9.5
B-514	....	184,000	229,000	..	54.8	..
4330 Mod.	O.Q.1600F. T.650F.	203,000	235,000	11	44	18(a)
HS 220	O.Q.1600F. T.610F.	195,000	237,000	11	42	16(a)
Tricent	O.Q.1600F. T.500F.	242,000	297,000	8	23	18(a)
Super Tricent	O.Q.1600F. T.400F.	.....	342,000	..	..	12(a)
En 24	O.Q.1550F. T.400F.	207,000	277,000	12	35	20
En 25	O.Q.1550F. T.480F.	185,000	224,000	14	50	24
En 27	O.Q.1525F. T.400F.	188,000	242,000	14	48	31
En 30B	O.Q.1500F. T.400F.	185,000	246,000	14	47	42
En 40C	O.Q.1650F. T.400F.	191,000	259,000	14	40	30
William Jessop and Sons, Limited Cast No. 4824	O.Q.1580F. T.550F.	220,000	275,000	12	37	16
Wm. Jessop and Sons, Ltd. Cast No. 4828	O.Q.1500F. T.550F.	189,000	246,000	12.5	40	20

(a) Charpy V-notch

been briefly described by Harris and Johnson. It appears that one of the most active companies has been the William Jessop and Sons, Ltd., who, besides testing some of the conventional British steels heat-treated at high strength level, has also tested some experimental compositions. The approach (as briefly mentioned previously) is to add up elements that will prevent the marked drop in impact strength at low tempering temperature and to adjust composition for the hardenability required. Silicon, aluminum, vanadium and others have been claimed to retard softening and drop of impact during tempering.

The analysis of some American and British steels (both conventional and specially developed) suitable for high strength use are given in Table 1. The best over-all properties are given in Table 2.

It should be noted that the properties shown in Table 2 could be varied. For example, the tensile strength can be increased but unfortunately at the expense of impact and proof stress properties. As noted previously, a few conventional constructional steels will give tensile properties similar to those obtained in newly developed steels. However, the former have to be tempered at a much lower temperature (400 to 450 deg F) than the latter to give these properties. The addition of elements such as silicon will retard softening and permit tempering at higher temperatures. It is felt that a more complete relief of residual stresses is thus obtained, together with a better yield tensile ratio. Moreover this higher tempering temperature is an advantage in the fact that the material may be used at working temperatures up to this tempering temperature. Gun barrels and rocket launchers, for instance, may reach a temperature of 450 deg F and even exceed it, with consequent lowering of room temperature tensile properties in a conventional steel heat-treated at super high strength.

The advantages of ultra-high strength steels unfortunately have to be paid for by an increase in the processing cost. General principles for the satisfactory processing of 4340 heat-treated at high strength level have been obtained after years of experimental work and practical observation. Most of these results would also apply to the newly developed steels and some of the most important of these results are presented here.

The proper heat-treatment of 4340 at high strength levels involves double tempering and austenite stabilization treatments. A subzero treatment to complete the austenite-martensite transformation is not used yet in production, for fear of the increased danger of cracking. But the technique has been studied and it has been observed that the ratio of yield stress to ultimate stress was increased when austenite was more completely transformed to martensite by this treatment. Another difference in heat treating procedure is that normalizing has been found to be necessary before austenitizing. Longer times at austenitizing and tempering temperatures are also necessary and consistent results will only be obtained if the above practices are put into use.

New machining techniques had to be developed for material of this high hardness. The rate of metal removal is necessarily very slow and in all possible cases the material is finish machined before heat-treatment or rough machined to about 0.050 in. on diameter. When necessary, and with proper equipment, high surface speeds of the order of 300 to 400 fpm can be attained and with good surface finish.

Grinding practice, cold straightening, cadmium or chromium plating and so on have all been reconsidered in view of their effect of introducing internal stresses in the metal. For example, cold straightened parts should be stress relieved and shot peened to remove surface tensile residual stresses. Peening is also used to counteract the effects of decarburization and stress concentrations. One of the most complex problems is that of hydrogen embrittlement. Cathodic cleaning, pickling and plating will embrittle a steel, that is, reduce the ductility, very severely. Treatments such as ageing at room temperature or baking for a few hours at 375 deg F seem to cause partial removal of hydrogen. Some other undesirable effects attributed to hydrogen will be discussed later. Standard methods for relief of embrittlement are being established. Flash welds and pressure welds can now be made satisfactorily, but in general close processing control will be required especially for plating and welding operations.

Conclusion

Although most of the above observations have been made with 4340 steel, indications are that these facts are also true for most ultra-high strength steels. The proper treatments for 4340 and Super Hy-Tuf heat-treated at super-high strength have been given in detail.

There is no doubt that high-strength steels will continue to grow in importance and it is to be wondered

(Continued on page 60)

"One line might be to try metal 'whiskers' as structural material."

Table 3: Super High Strength Steels in Use

Type	Aeronautical Materials Specifications No.
5340	6415
4330 Modified	6427
HS-220	6407
Hy-Tuf	6418

Table 4

	Conventional Treatment	Cold worked in Austenitic Condition
Yield point	295,000 psi	400,000 psi
Hardness	56.5 Rc	58 Rc
Elongation	2%	12%
Reduction in area	5%	42%

3-D model

Layout plan that assembles in seconds

Calgarian invents a scale model that makes child's play of floor plans

Douglas Stephens was taking a commercial art course when he and his wife decided that they would build a home on their return to Calgary. An obliging fellow-student offered to draw up preliminary sketches of the house but found that the subsequent alterations in the plan called for long and tedious work. Why, thought Stephens, could not these preliminary architectural lay-outs be made with some sort of model that could be changed quickly and easily? The idea seemed to be good but, like so many such ideas, it lay fallow for some time.

Now, however, Stephens has patented the product of his imagination and is producing it under the name Arcotec. The Arcotec kit is extremely simple and yet, when Stephens sought a patent, he found that no one had sought such a patent before.

The device, which is prepared like a do-it-yourself kit, consists of a serrated plastic base and lengths of cardboard. The base and the cardboard are scaled ¼ in. to the foot—the scale most commonly used by architects and builders in preparing plans. The dimensions of the precut cardboard correspond to a 6-in. wall 8 ft. in height (other heights are easily cut). With the aid of a scale ruler, which is part of the kit, and a pair of scissors, a wall of any length can be cut. The walls and partitions are then set into the serrated base and, in a matter of minutes, the miniature house takes shape.

Endless combinations

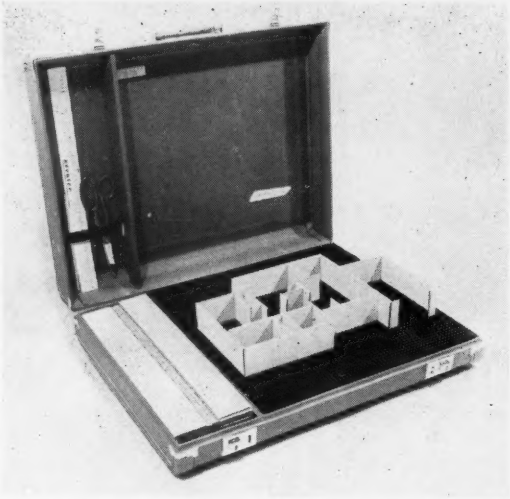
The advantage of this three-dimensional model is that an architect's client (and more important, the client's wife) can see at a glance what their house is going to look like. If a room appears to be too small, or the wrong shape, the layout can be changed in seconds. The advantage of this visual aid can be appreciated, too, for people unable to read building plans.

The kit is not intended to substitute for a builder's plans, emphasizes Stephens, but it does give both the builder and his client a clearer idea of what will result from those plans. Since changing plans on paper is a slow and costly business, a clear decision as to proportions is a great timesaver in preparing the working drawings.

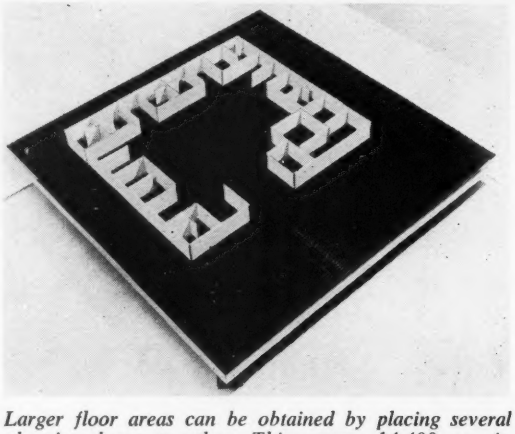
When a more permanent model is required, the plan is reversed in the base and glue is run along the top edges of the walls. A base piece can be weighted down onto the glued edges and, when the glue sets, a model (the right way round) can be pulled out of the serrated plastic base.

Production problems beset Stephens for some time. He had hoped to have the complete kit made in home-town Calgary but it proved impossible. Special dies for the base came from Chicago and they are manu-tured in Vancouver. An Oshawa firm supplies the scale ruler and the special scissors come from Montreal.

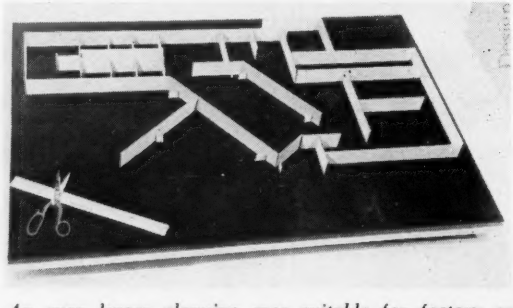
Most of Stephens' present customers are architects and builders but it has been suggested to him that a smaller kit might prove popular as a children's toy. Manual training and drafting teachers have also ex-pressed interest in the Arcotec kit for instructional pur-poses. There may be more to Stephens' idea than he thought.



The portable kit contains 3,600 sq. ft. of planning area and holds firmly in place when the lid closes.



Larger floor areas can be obtained by placing several planning bases together. This covers 14,400 sq. ft.



An even larger planning area suitable for factory or office layout has been assembled here — 21,600 sq. ft.

Applying a nickel base wearproofing alloy by a two-pistol setup. This is a plunger for a hydraulic pump.

Workshop practice

A hard facing you apply with a spray

Applications seem limitless for this flexible method of wear-proofing

Advantages of the Sprayweld process are:

(1) Less time is required to spray and fuse than to apply the overlay with a rod. Less time is required to finish grind the part because the overlay is smooth and much closer to finish dimensions than that of a hand welded part.

(2) Less material is used with Spraywelding than with hand welding because the thickness of the overlay is easily controlled to within 0.010 in. A uniform deposit of any thickness up to 1/16 in. may be obtained.

(3) The surface lasts longer and the Sprayweld process eliminates pinholes, checks cracking, distortion and other common defects inherent in ordinary welding procedures.

The practice of protecting metal parts from wear by welding a layer of wear-resistant metal over them is known as hard-facing. It can be carried out on worn parts, to replace metal lost through wear as well as on new parts when wear is anticipated.

Hard-facing has many advantages. A part protected with a properly chosen and applied hard-facing alloy will last much longer than an unprotected part. This means that fewer replacement parts will be needed, less labor will be required to install them and that the equipment will be subject to less down-time. In fabricating new parts, inexpensive base metals may be used because the hard-facing will take the wear.

To be fully effective, the hard-facing material used must be resistant to the particular wear encountered—and there are many forms of wear. The name Colmonoy stands for a complete line of hard-facing alloys. Each alloy is resistant to one or more of the four main forms of wear: impact, abrasion, corrosion and heat.

To suit different application methods, these alloys

Spraying a bottle mold. Molds so protected are lasting 5 to 6 times as long as the unprotected molds.

are available in various forms: as oxy-acetylene rods, electrodes, paste, powder, wire and castings.

The alloys contain crystals composed of chromium borides. These are extremely hard, just below diamond on the hardness scale. They are stable compounds, having excellent resistance to corrosion and high temperatures.

Other qualities imparted to these hard-facing alloys by the crystals include: excellent weldability, hot hardness, galling resistance (a low co-efficient of friction) and a low application melting point (a saving in gas and time).

In the Sprayweld process, the powdered alloy is sprayed on the part to be hard-faced (as in the ordinary metal spraying process) and then the overlay is fused to the base metal with an oxy-acetylene torch. This combines the controlled application of metal spraying with the true molecular bonding of welding.

The Sprayweld process is made up of three main steps:

(1) Preparation of the surface to be sprayed by grit blasting. This is important because it insures the mechanical bonding of the sprayed deposit to prevent its lifting during fusing.

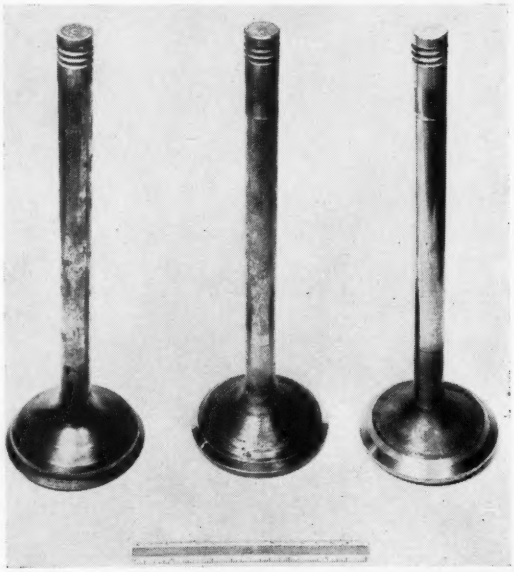
(2) Spraying the prepared surface with a Colmonoy alloy powder, using a Spraywelder unit hand-held or mounted on a lathe.

(3) Fusing the sprayed overlay. The part is heated with an oxy-acetylene torch or in a controlled atmosphere furnace to a temperature of 1,900 deg. F. The previous mechanical bond now becomes a fused or welded bond and the part has an integral solid alloy surface. It will withstand corrosion and abrasion much longer than hardened steel.

The Spraywelder is a powder metal spraying unit, designed expressly for the process. It is a low-cost, simple, dependable unit.

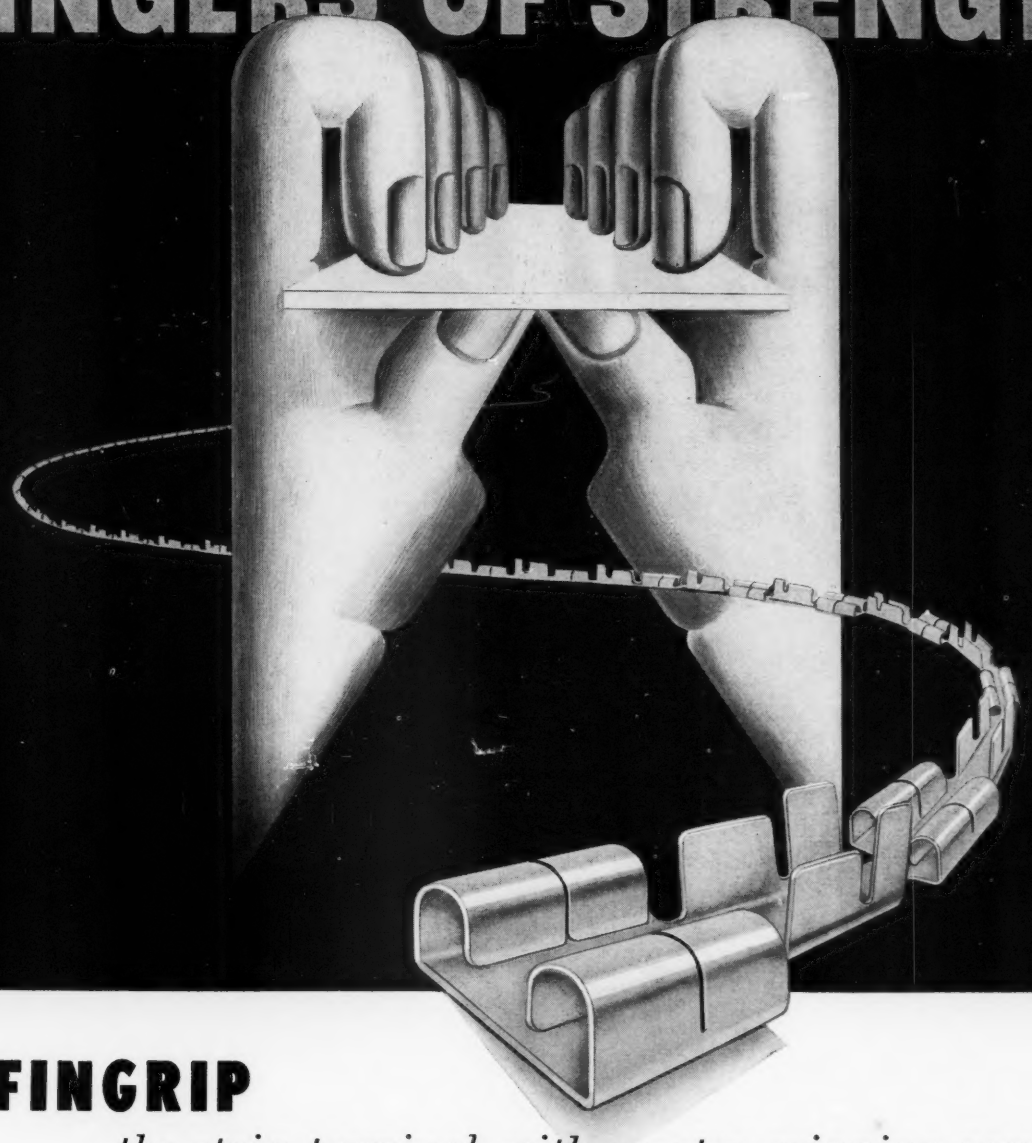
Ordinary metalizing applications of copper, aluminum, nickel, stainless steel, brass, lead, tin and zinc can also be performed with the Spraywelder.

Applications of the process are so many that its full use seems almost limitless. A few of these are shown.



Left to right: A new diesel valve worn out after 4,000 hrs. use. Colmonoy-coated reclaimed valve after identical use. A valve reclaimed by spraywelding before use.

FINGERS OF STRENGTH



FINGRIP

—the strip terminal with greater gripping power

Get stronger, more uniform and faster low-cost wire terminations with the new Burndy FINGRIP. Unlike ordinary terminals of this type, FINGRIP, with strong, gripping finger-like construction, gives not two, but *four* individual gripping actions with the pressure evenly distributed over the large contact area.

A dimpled catch in the rugged, solid back of the FINGRIP provides a ratchet, locking action which maintains a consistently uniform pull-out value — even after the connection has been made and broken many times. Stronger, better conductivity joints are assured by double snubbing action of the exclusive wave-type indents.

- *Finger-like grip — grips stronger.*
- *Pressure distributed over 5 points.*
- *Ratchet catch increases gripping power.*
- *Double snubbing action of wave-type indents assures high pull-out strength for solid or for stranded conductors.*
- *Insulation grip accommodates all types of insulation.*

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Installation presses for FINGRIP terminals operate as swiftly as stripped wire ends can be fed. Insertion of the wire automatically actuates the press . . . no levers, no pedals are needed. This speed plus the structural method of maintaining pull-out values offers new production advantages and economies.

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File

New booklets and books written for you

Radiography data

A new 12-page booklet, containing operating and application data on six different types of radiography units, is available from the Scientific and Industrial Department, **Rogers Majestic Electronics Limited.**

Instruments covered include: 60 kvp lightweight portable radiographic-fluoroscopic unit; 160 kvp, 360-degree circumferential port unit; 150 kv constant potential unit; 300 kv constant potential unit; and 260 kvp self-contained portable unit. Information is given also on an industrial image intensifier and closed-circuit television installations.

The booklet shows photos and characteristics of all instruments listed and explains how they are used. There are three charts. One indicates the proper unit to use for various thicknesses of steel and aluminum. Another shows the penetration values of different alloys and metals, compared with steel. The third gives exposure data for steel. (200)

Rotary Gear Pumps

A 14-page rotary gear pump catalogue is now available from **Northern Ordnance Incorporated.** This catalogue gives complete design, performance and engineering information regarding their nitralloy steel block pumps, as well as general engineering information on viscosities, pipe velocities and sizes. Pump sizes range from ¼ gpm to 146 gpm. Used for transportation, hydraulic and industrial applications, nitralloy pumps are used to pump all oils, propane, ink, asphalt, shellac, molten lead and countless other products. (201)

Gas Producers

A new, four-page publication GEC-1391 giving application data, product descriptions, dimensions, ratings and diagrams of Thermalene (endothermic) gas producers for production of protective atmosphere gases for heat treating, is available from **Canadian General Electric Company.** (202)

Vibration pickups

A six-page bulletin, No. 124E, describing both vibration pickups and meters, has just been published by **MB Manufacturing Company** (a division of Textron Inc.) for use by design and test engineers engaged in precise vibration analysis. Technical information and illustration on the velocity-type pickups includes design and method of operation, general specifications and typical frequency-response curves for damped and undamped types. The new MB Type 115 hand-held probe-type pickup is also described in detail. Design features and performance specifications are given for models M-1 and M-3 vibration meters.

Of particular value in selecting the proper pickup for particular vibration test requirements is the detailed table giving natural frequency, damping factor, dc coil resistance, available stroke and sensitivity for 16 of the many MB vibration pickups with ball-bearing or jewel bearing suspensions. Maximum limits on shock and acceleration magnitude and temperature are given for appropriate types of pickups. (203)

Detection system

A well-illustrated brochure describing a semirigid harness and thermocouple detection system for jet engines is available from **Fenwal Incorporated.** The booklet shows construction details of the prefabricated harnesss and its method of assembly on the aircraft. A feature of the harness consists of button terminals which serve as contacts between the individual thermocouples and the detection circuit. By eliminating terminal studs, button terminalization sharply reduces installation time and simplifies thermocouple replacement, since the harness can be left intact. Balancing resistors in the harness make rebalancing unnecessary after the thermocouples are replaced.

The brochure also describes Fenwal button-terminal thermocouples and the various manufacturing details designed to eliminate contamination and provide resistance to vibration. (204)

Broaching machines

Mechanical details and operating advantages of the ElectroGear line of horizontal guided-ram type surface broaching machines, designed and built by **Colonial Broach & Machine Company,** are given in Bulletin HM-56. The four-page bulletin lists machine data for the 12 models in the line that have normal capacities of 10, 15, 20 and 25 tons and stroke lengths ranging from 90 to 240 in.

The bulletin also contains photographs and brief descriptions of typical jobs that have been broached successfully. These machines are designed for use in either automated or manually loaded installations, depending on the requirements of the particular application. (205)

Book Department

The Analysis of Structures

Many students of engineering consider the analysis of structures a rather boring subject. They do not understand the justification of the assumptions made and they get tired of memorizing scores of unrelated formulae, rules and procedures. It is the hope of the author **Professor N. J. Hoff,** that in this volume he has proved these objections to the theory of structures to be unjustified, because the study of structures can be an exciting undertaking. The various methods used by structural engineers are all logically interconnected if one looks upon them from a unifying standpoint. Not a single formula need be memorized if the fundamental principles are understood. Every method presented in this book is an almost obvious consequence of the basic principles and can be derived with a minimum amount of mathematical manipulation. The various devices suggested for increasing the accuracy of the calculations and reducing the work involved may appear as tricks to the uninitiated. But to the reader of this book, these devices should become obvious applications of the basic principles.

The first purpose of this volume is therefore the presentation of structure analysis as a logical and unified theory based on a small number of first assumptions. To achieve it, the principle of virtual displacements is chosen as the starting point. The second purpose is the development of the minimal principles of structural theory; they have been used so generally in the engineering literature of the last few years that no modern practising engineer can afford to ignore them. Finally, an effort is made to give a thorough understanding of buckling.

The fundamental information is presented in the early part of each section of the book. The rest of the book contains applications to various structures and principles of a less fundamental nature. It can be read by a person with some experience in structural analysis in almost any order. To facilitate a random study of the various problems treated, reference to preceding articles have been kept to a minimum. Of course, the beginner will find it easier to follow the text in the order presented.

Footnotes are used sparingly because they tend to disrupt the continuity of presentation. Remarks usually given in footnotes are collected in an appendix which also serves as a bibliography.

It is hoped that the reader, who approaches the subject for the first time, will find it just as interesting as the author, who has had over twenty-five years of experience in studying and applying it, and fifteen years teaching it. Published by John Wiley and Sons, Inc., the book costs $9.50 and is worth it.

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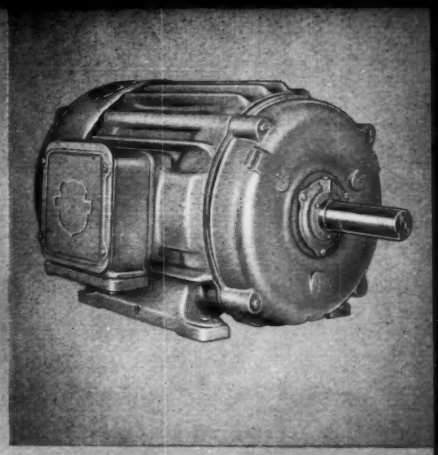

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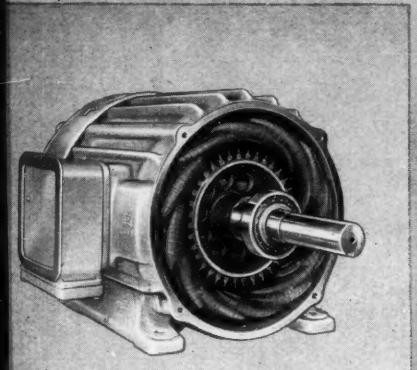

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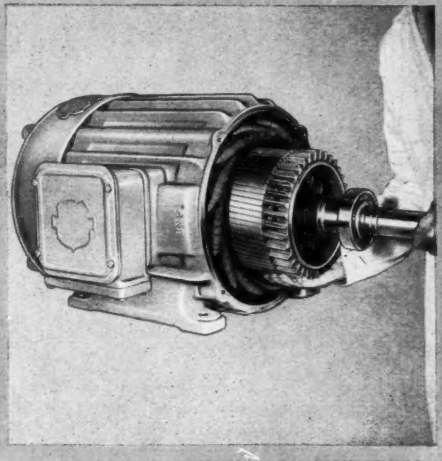
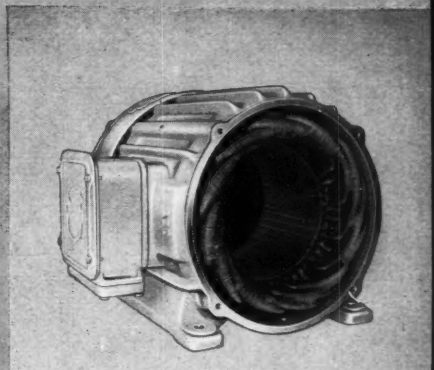
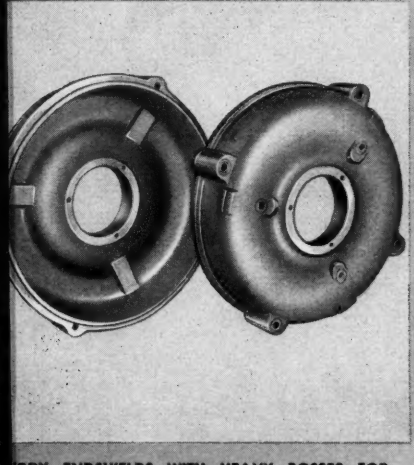


RUGGED ROTOR ASSEMBLED ON HIGH TENSILE STEEL SHAFT — ALL DYNAMICALLY BALANCED.



SLOTS LINED WITH MICA, WINDINGS INSULATED WITH THE LATEST FORM OF POLYMERISED SYNTHETIC ENAMEL, ALL THOROUGHLY IMPREGNATED WITH SYNTHETIC RESIN VARNISH TO GIVE HIGH PROTECTION AGAINST SEVERE OPERATING CONDITIONS.



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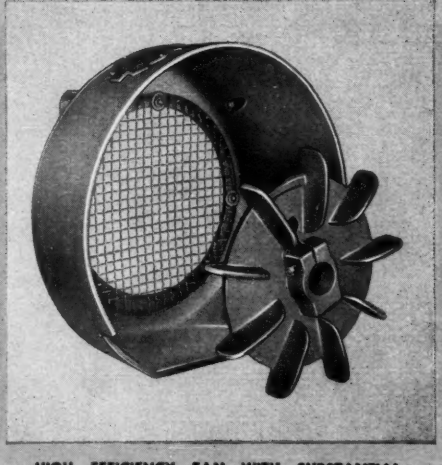
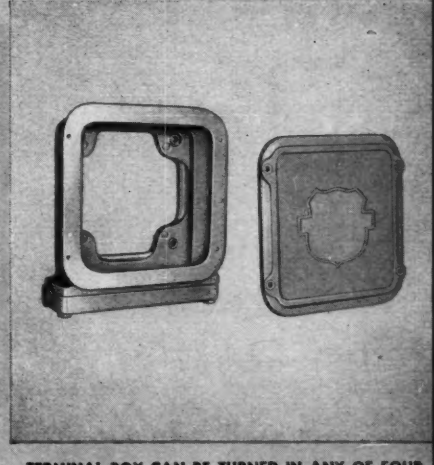


HIGH EFFICIENCY FAN WITH SUBSTANTIAL PROTECTIVE COWL.



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New products & materials

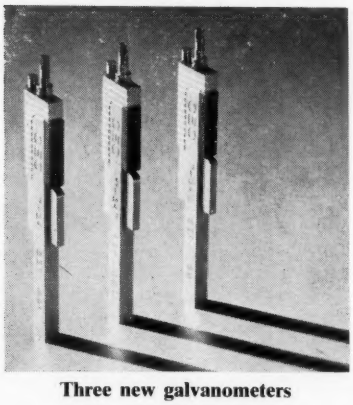
New items which can help you on the job

Galvanometers

Three new instruments with extended frequency and sensitivity ranges have been added to the 7-340 series of high-performance galvanometers by **Consolidated Electrodynamics Corporation.**

These newest members of the 7-340 family of galvanometers provide high frequency response without sacrificing sensitivity. For the same frequency range as on previous galvanometers, sensitivity is quadrupled, thus opening a completely new field of low output strain-gauge applications. In general, the higher performance in the new galvanometers has been accomplished by further miniaturization of microscopic moving parts, made possible by new materials and production techniques.

Two of the three new types (7-347 and 7-348) are designed to match the commonly-used strain-gauge-bridge resistance of 120 ohms. The third type (7-341) matches resistance bridges of 350



Three new galvanometers

ohms. Such resistance matching results in maximum system efficiency. All models in the 7-340 group are completely interchangeable with any of CEC's 8-300 series galvanometers. (206)

Automatic counter

A compact device that automatically counts and then, at some particular time, prints the count, has recently been developed by **Royson Engineering.** The device, called the Model RI-4 Identichart, will print at regular intervals so that it is possible, when reviewing the chart, to determine the number of counts in any particular time period. The unit is ideally suited for a print-out device for integrators and mounting can be provided for all popular makes of recorders. It can also be supplied as an independent unit for printing on a card or adding machine tape. The Model RI-4 can be supplied with as many as 8 digits so that a maximum count of 100 million is possible. Printing does not affect the counting which can therefore continue after printing the particular number, since the counting circuit and printing circuit are independent of each other.

Both the counting solenoid and the printing solenoid can be supplied for 24 to 220 volts dc and rectifiers can be supplied for use on ac if desired. To make installations easy the Identichart is supplied in kit form with a plexiglass window for the recorder and a plexiglass cover for the printer. (207)

Portable PA system

A portable public address equipment TPA/569, has been designed by **Lustraphone Ltd.** to operate as a completely self-contained and fully portable PA system. It consists of:

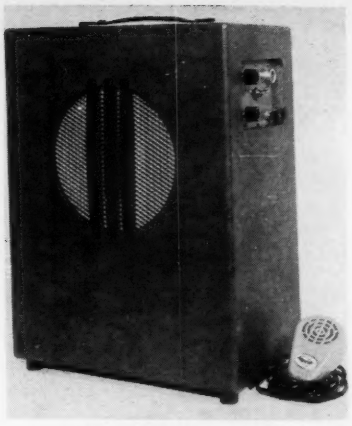
(a) Fully transistorized amplifier.

(b) High Fidelity 8 in. loud speaker.

(c) Set of 12 volt dry accumulator batteries.

(d) Model HD/54, dynamic lightweight low impedance hand microphone, complete with cable and press-to-talk switch.

The amplifier is a fully transistorized 10 watt transamp (Registered Trade Mark) Model TPA/556. This unit has a level frequency response from 100 cps to 10 ksc and requires an input of 5 millivolts or less for maximum output. Harmonic distortion is less than 5%. Tone and volume controls are provided which, together with the on/off switch, are conveniently located on the side of the case housing the complete equipment. The amplifier is powered by a 12 volt, 7 ampere hour, dry battery from which the current drain averages 0.5 amp. This enables the amplifier to be used continuously for a period of 14 hours before the accumulator is due for recharging.



The 24½-lb. system

The microphone provided is HD/54 dynamic lightweight low impedance hand microphone of sufficient sensitivity to drive the amplifier and having a frequency response in keeping with that of the amplifier. A press-to-talk switch is incorporated in the microphone housing.

The complete equipment is housed in a handsome and soundly constructed weatherproof case to withstand the arduous use to which most portable equipment is subjected.

Ready access is provided to the battery compartment and a felt-lined microphone pocket is also provided inside the case for convenient stowage.

Dimensions of the case are: Height 17½ in., width 13¼ in., depth 8½ in. Net weight of equipment 24½ lb., weight in carton 27 lb. (208)

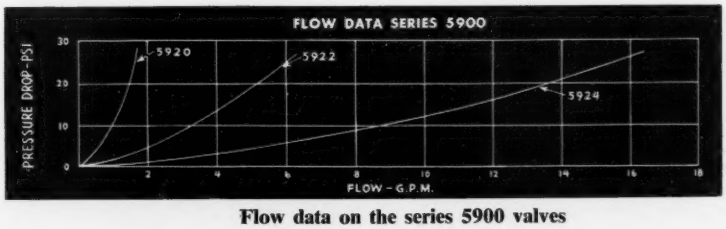
Check valves

The newly established Tactair Valve Div. of **Aircraft Products Co.,** announces the availability of its new rotary-type controllable check valves for 3,000 psi.

Constructed with stainless steel internal parts in an aluminum alloy housing, Series 5900 valves have no leakage at 3,000 psi and only 1 dpm at 5 psi.

Standard units are designed to handle liquids within the temperature range of 65 to 160 deg F.

Special units are available for handling wider temperature ranges. Cracking pressure on these units is 2 to 8 psi. The relationship between pressure drop and flow (gpm) for this series is shown in the graph. (209)



Flow data on the series 5900 valves

Continued on page 64

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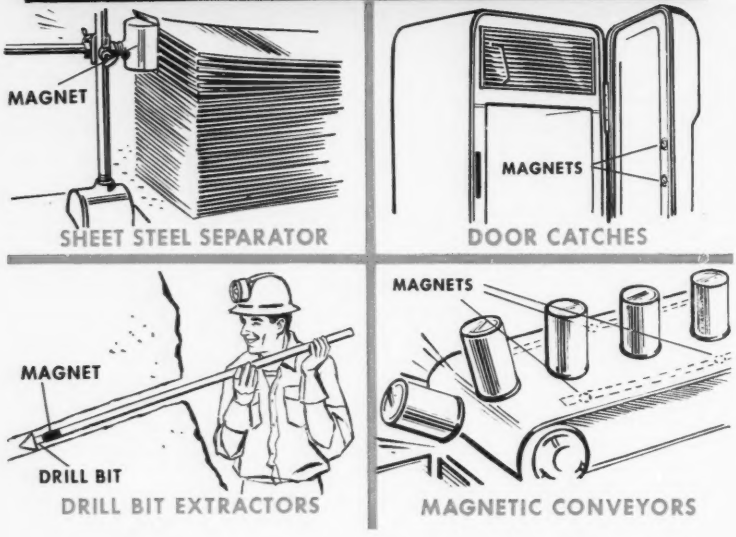

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Super steels

(continued from page 51)

just what the maximum attainable strength will be. Then which direction will the race for stronger and better materials take? Research may be done to improve the transverse impact properties of super high-strength steels. Rare earths have been shown to increase transverse toughness of 4340 and probably have the same effect on other high-strength steels. With impact properties improved steels could possibly be heat-treated to still higher strengths. The yield stress-to-ultimate strength ratio is rather low in most of the super high-strength steels. Strain-ageing would certainly increase this ratio from about 0.80 to above 0.90 and only a limited amount of work has been done along these lines.

Even in super high-strength steels, prestressing may cause an increase in the performance limit. This treatment was applied to a small ordnance forging (a bomb shackle hook) that had the necessary static strength but was not satisfactory in fatigue resistance. By prestressing to introduce compressive stresses in the region where fractures were initiating, the number of stress reversals to cause a fatigue failure was increased from 5,000 to 25,000.

Another approach may be that of new hardening techniques. Lips and Van Zuilen have shown that unusually high yield-strengths are acquired by steel "cold-worked" in the austenitic state, just below the nose of the T-T-T curve and then transformed during air cooling. The properties obtained in a 4.5% Ni, 1.5% Cr and 0.35% C steel when heat-treated in the conventional way and when "cold worked" in the austenitic range are given in Table 4.

When all other possibilities have been explored it is likely that the only other alternative might be the use of metal "whiskers" as structural materials. These are dislocation-free single crystals formed by a natural growth process. Whiskers of pure iron of dimensions 0.001 in. thick by 1 in. long have already been obtained and have given tensile strengths exceeding 900,000 psi. Hardy has predicted that if whiskers can be used as seeds for filaments, such filaments could be assembled into cables for structures.★

KWIZ KORNER

Do you know what these are?

1(a). Archimedes' principle
1(b). Archimedean spiral
2. Tempilstiks
3. Bessel function
4(a). Voussoir arch
4(b). Vierendeel frame

Answers given on page 69

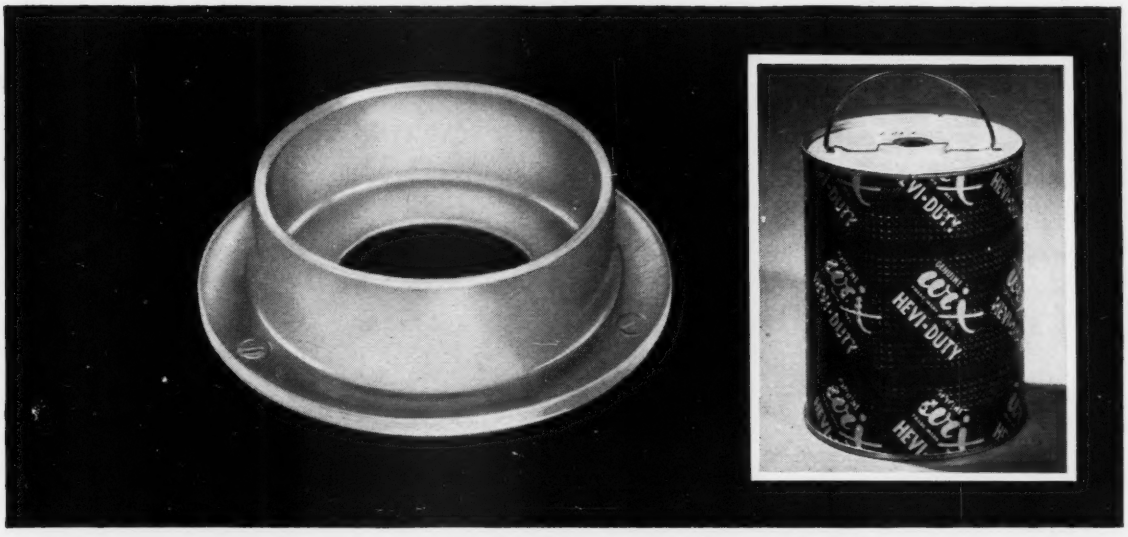
DUPONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

"ZYTEL"* nylon resin chosen for a Filter Seal

"Wix" oil filter shows how an outstanding material and good design improves quality at no increase in cost.



Simple nylon moulding gives better seal, longer life and simplifies assembly of famous "Wix" oil filter cartridges. Moulded for Wix Accessories Limited by Smith & Stone Limited, 50 St. Clair Avenue West, Toronto 5, Ontario.

Here is a development typical of a great many product improvements brought about through the use of "Zytel" nylon resin when good design is used.

The seal on the "Wix" oil filter must be stable and remain tight under operating temperature ranging from 40° or 50° below zero to 200° or more above zero, to say nothing of resisting degradation due to exposure to standard motor oils at these temperatures.

Originally the seal was a three part laminate of fibre, steel and rubber which required two assembly operations to install. Applying its knowledge of the properties of nylon to the job required, "Smith & Stone" is now moulding this one-piece part which provides tangible savings in cost and a most efficient seal. Testing indicates to "Wix" that it will far outlast the life of the filter. "Wix" now confidently advertises that no oil can by-pass "Wix" Nylon Seals. These seals will not soften in use under any condition — will retain their exact size and shape. In actual service for nearly three years, these seals have exhibited no sign of failure.

OVER

The protective shield of "Lucite" acrylic resin on this Kalart flash attachment was molded by T. F. Butterfield, Inc., Naugatuck, Connecticut.

Crystal-clear safety shield of LUCITE* protects against flashbulb shatter

BECAUSE it is transparent and durable, "Lucite" acrylic resin offers outstanding advantages. Its high impact strength and weather resistance afford long wear and heavy-duty service. "Lucite" gives optimum transparency and can be colored to provide unusual decorative effects.

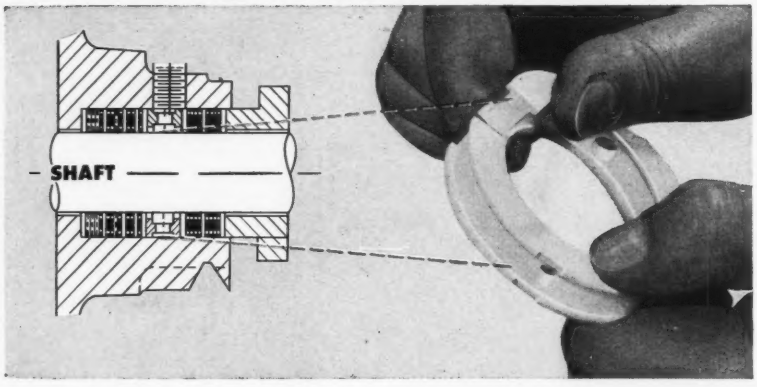
An interesting application of this engineering material is in the new Kalart flash attachment. "Lucite" is used for a safety shield protecting subjects from possible shatter of flashbulbs. Economically molded, "Lucite" withstands heat without discoloring.

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Du Pont TEFLON* for flexible seal cages which snap in place easily, won't score shaft



Effective sealing without danger to the shaft is possible with seal cages of "Teflon". These flexible cages snap on and off quickly and give long wear under rugged conditions. (Manufactured by Chemical and Power Products, Inc., New York, New York.)

"Teflon" is strong and chemically inert through a wide temperature range

THESE flexible seal cages of Du Pont "Teflon" tetrafluoroethylene resin supply annular space in packing for lubrication with oil or grease, or for cooling. Users of pumps and other process equipment will appreciate how quickly and easily these flexible seal cages of "Teflon" snap on and off a shaft. They're tough—won't bend or collapse under extreme gland pressure. Yet, because "Teflon" is non-adhesive, there's no danger of a scored shaft or sleeve from these seal cages.

"Teflon" is used extensively in chemical, electrical and mechanical applications. Its chemical inertness, high heat resistance ("Teflon" operates in many applications at temperatures as high as 500°F.), low temperature toughness, and low coefficient of friction make this engineering material particularly adaptable to severe service conditions. Possibly "Teflon" can solve an engineering problem for *you*.

Shield of ALATHON* solves insulation problem in new RCA Victor color TV receiver

THE PICTURE TUBE in the new RCA Victor color television receiver operates at 25,000 volts. To provide insulation for this tube, RCA engineers needed a material that could be readily and inexpensively molded into the complex shape of a kinescope shield . . . yet had high dielectric strength. Du Pont "Alathon" polyethylene resin proved to be an ideal material for the shield on all counts. In addition to providing the needed insulation, the shield of "Alathon" gives mechanical protection to the tube when it is shipped or handled.

"Alathon" not only has excellent insulating properties but is strong, lightweight and

flexible. It is chemical resistant, as well as odorless, tasteless and non-toxic. Because of these properties, and the ease with which parts can be molded, extruded or fabricated, "Alathon" has helped engineers solve many design and operating problems.

DE-6

DU PONT COMPANY OF CANADA LIMITED,
CHEMICALS DEPARTMENT, Room A-4, P.O. Box 660, MONTREAL, QUE.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

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Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties, available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin, are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

Biggest Silicone Rubber Roll made possible by unique compound

What! Silicone rubber in thick sections? It couldn't be done! But today *it is done* with a new UNION CARBIDE Silicone Rubber Compound. Witness the product in the accompanying picture—a silicone rubber roll 55 inches long by 8 inches in diameter—believed the largest ever built.

Most astonishing of all: The costly, step-by-step curing cycles, once necessary to prevent blowing and delaminating, give way to a one-step cure.

You might find a use for such a roll in a paper mill, or in textile machinery, where non-sticking qualities are important. You might find other uses for UNION CARBIDE Silicone Rubber and Compounds for products that must remain flexible at very low temperatures, resist high heat, provide extremely low compression set, or offer resistance to ozone, corrosive atmospheres, or electricity.

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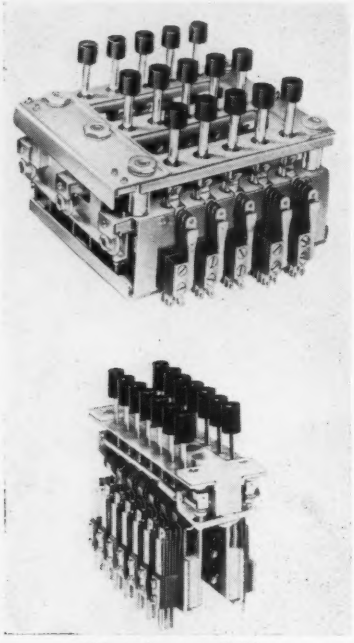
New products
continued

Push-button switches
Two new types of interlocking push-button switches, mounted in parallel row assemblies to provide a maximum number of interlocked stations, have been introduced by **Donald P. Mossman Inc.**



36 stations available

The Series 5900 is available with up to 36 interlocking stations. Each station may be equipped with various contact combinations, rated at 3 or 5 amps, 110 volts ac (non-inductive).

Normal operation provides that depression of each button releases any previously operated station and itself locks in the operated position.

Additional construction features include a lockout to prevent operation of more than one station at a time, a solenoid release and non-locking stations. Series 5900 may be had with individually illuminated buttons, whilst Series 5700 is available with accumulative lock-in construction. (210)

Sound projectors
As a result of a single-switch film reversing mechanism on new **Canadian Kodak Co., Limited** models, Kodascope Pageant sound projectors will have greater operating convenience and versatility.

This enables a projectionist to run off as much film as necessary in checking for proper focus, loop or sound volume and then, with a flick of a switch, reverse the film to starting position. Time previously taken up by rethreading the projector can now be saved and film life prolonged by elimination of the extra handling. (211)

Liquid level gauge
Remote reading liquid level gauges are now available as inclined gauges for use where they have to be mounted high or low on the instrument panel, or at other points. **Jerguson Gage & Valve Co.** announce that the new inclined Truscale gauges are available in all remote reading gauge models. For high installations, the case is built so that the cover and scale incline upward.

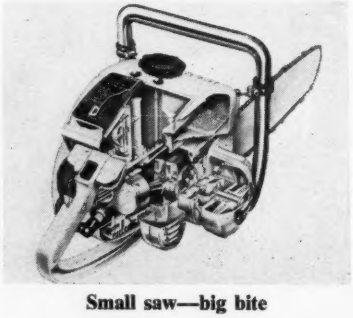
Truscale gauges give instant remote reading of liquid levels of boilers, tanks and so on, with an accuracy of half of 1% of scale reading. They bring the liquid level to where it can easily be seen. They have a convex face, with scale marking directly on the face, giving 180-deg. visibility. Truscales can be read from any point from which the face can be seen, and the inclined types make possible a very high or a very low installation that still gives maximum visibility. (212)

Chain saw
A new direct-drive chain saw that incorporates many new design features has just been introduced by **McCulloch Company of Canada, Ltd.**

The new lightweight power saw — the D-44 — has more horsepower per cubic inch displacement than any other direct-drive chain saw, it is claimed.

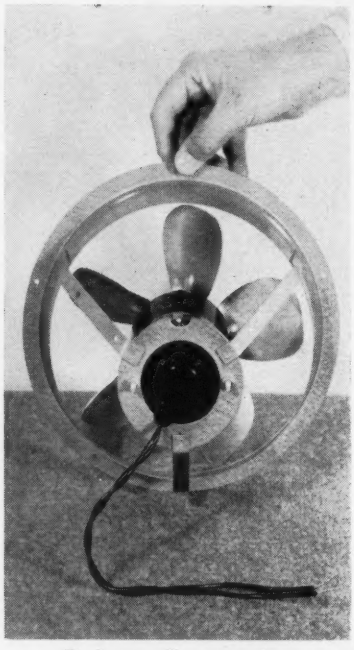
In the direct-drive D-44, the chain sprocket is connected directly to the crankshaft through an automatic clutch, giving a chain speed of about 3,000 fpm, or about three times the chain speed of a gear-driven saw. This high chain speed reduces the effort necessary by the operator to feed the chain into the wood.

An important feature of the new saw is its crosswise balance said. The c.g. is virtually on a direct line between handle and blade. This enables the saw to cut straight through a log without requiring constant correction by the operator. At the same time, however, the location of the blade permits the cutting of trees close to the ground. (213)



Small saw—big bite

Cooling fan
The production of a new fan suitable for a variety of electronic cooling applications is announced by **McLean Engineering Laboratories,** manufacturers of electronic cabinet cooling fans. Model 1E80 features air deliveries of 330 or 395 cfm at zero pressure. Dimensions are 8 in. fan diameter and 10½ in. OD. Motors are available totally enclosed or open and operate on 15 volts, 60 cycles at 1,500 rpm. The case has a grey hammertone finish with mounting holes located 72 deg. apart and 4¼ in. deep.



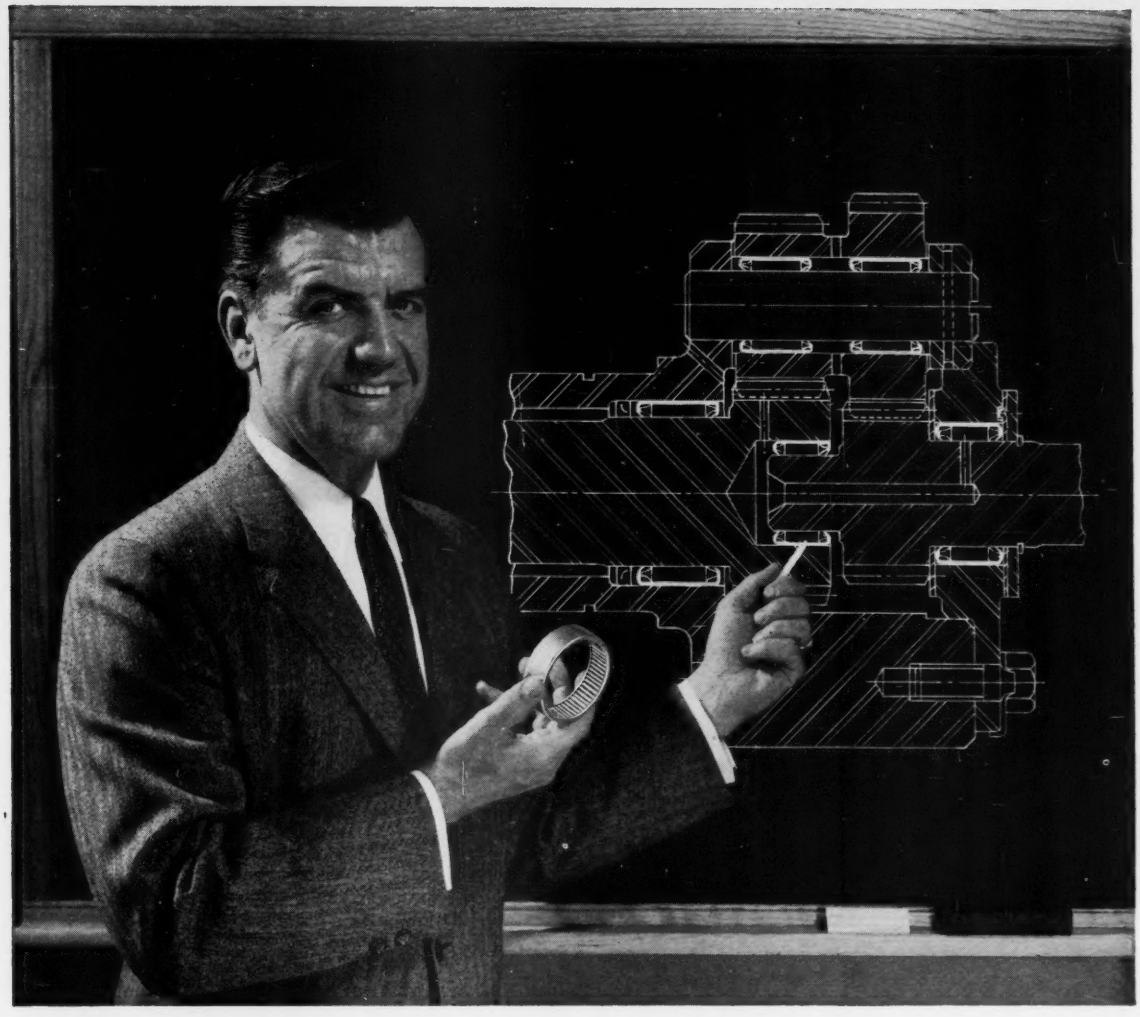
Push or pull over motor

The fan may be used in any position and is available in other sizes and modifications with air flow push or pull over motor. (214)

Expansible compounds
Two new thermosetting, self-curing polyisocyanate foams, for insulating and reinforcing voids between structural members, are now available from **Minnesota Mining and Manufacturing of Canada Limited.**

Known as Scotchfoam brand expansible compound Type A and Type 1, the foams are especially suitable for filling cavities where light-weight, structural strength, stiffening, vibration dampening and durability are desirable factors.

Both compounds are a two-part liquid formulation which, when mixed with a catalyst under proper conditions, can be foamed-in-place to produce a rigid cellular material that will not break loose, settle or sag. Application to desired areas may be made by pouring or spraying. Scotchfoam 1 has a volume expansion of approximately 20 to 1. (215)



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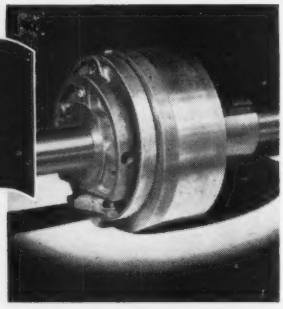

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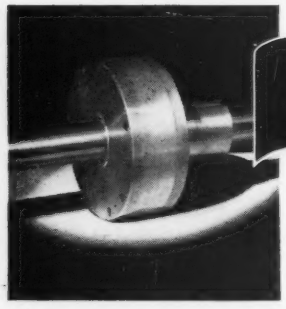

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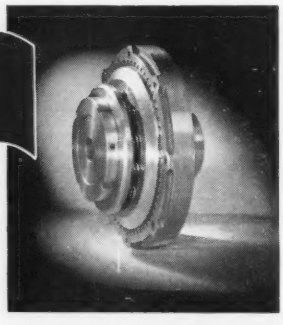

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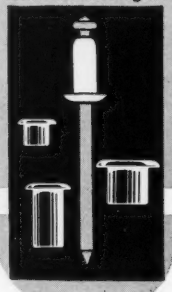

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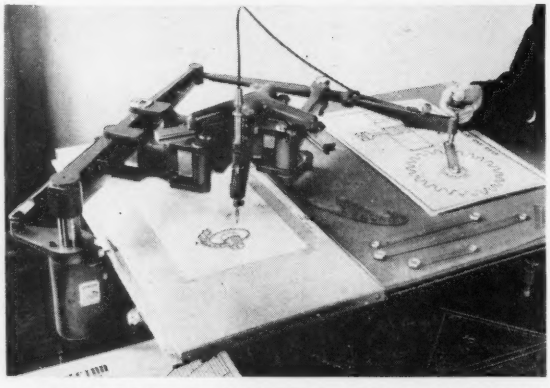

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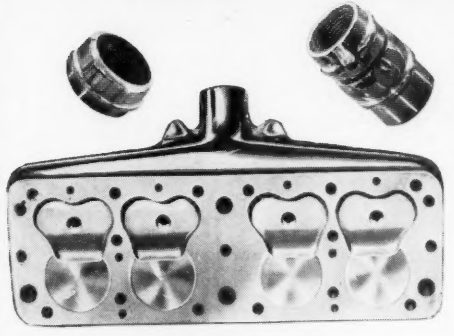

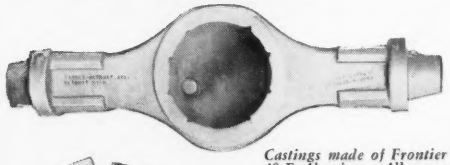

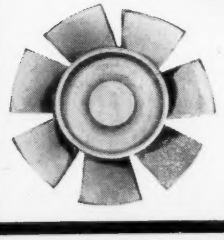

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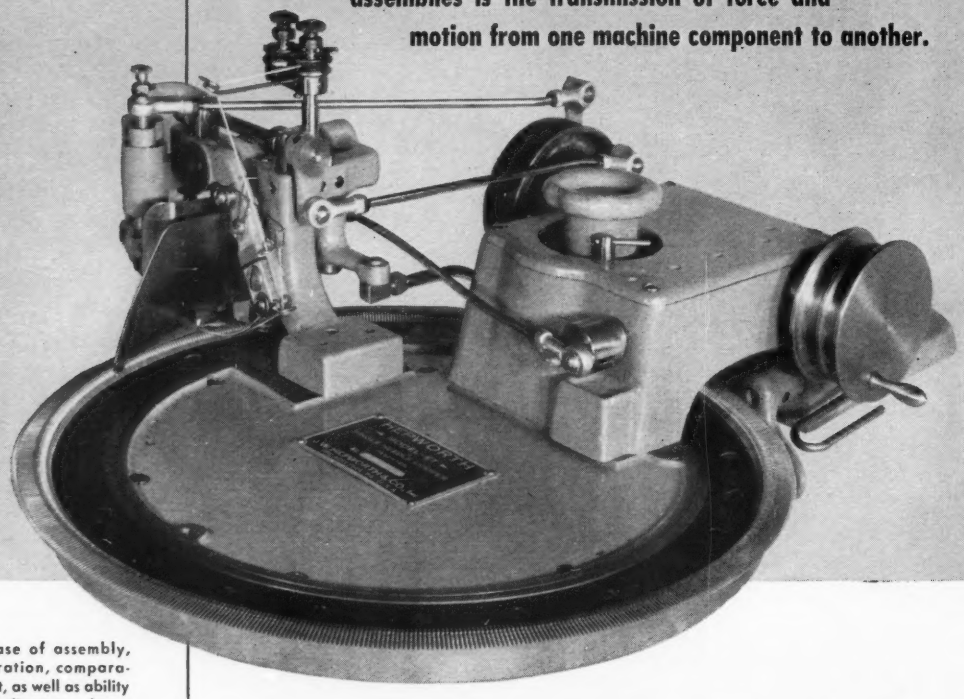

For their ease of assembly, smooth operation, comparatively low cost, as well as ability to correct misalignment, choose Heim Unibal Rod Ends.

In the operation of the Sweater-Looper, made in Philadelphia by John W. Hepworth & Co., there is a horizontal drive rod, a vertical drive rod, and a needle drive rod. At both ends of each drive rod are Heim Unibal Rod Ends — for smooth, trouble-free, continuous production.

The Hepworth Sweater-Looper is used for all types of sweater collars, sleeves, and shoulders. Collars can be set on a completely assembled knitted garment in a single continuous operation. Heim Unibal Rod Ends perform so well on the sweater-looper that Hepworth has redesigned their hosiery-looper to include Heim Rod Ends in the linkage assemblies.

Write for complete catalog, or for any engineering advice.

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FACTORY REPRESENTATIVES AND DISTRIBUTORS FOR CANADA

Air Impellers

(Continued from page 35)

static efficiency, consider only those impellers for which this operating point is located quite near the top of the slope.

Step 5 The impellers which are found to be possible selections in Step 4 must now be evaluated with respect to the physical requirements on space, impeller horsepower, cost, quietness — and possible additional design considerations such as desired sales features, weight, orientation and accessibility. Because most of these factors are interdependent, it is good practice to consider all together in studying the relative merits of each possible impeller selection.

Answers to KWIZ KORNER

(Questions are on page 60)

1(a). **Archimedes' principle.** When a body is immersed in a liquid its apparent loss in weight (caused by the upthrust of the liquid) is equal to the weight of the liquid displaced. The specific gravity of a body, which equals the weight of the body divided by the weight of an equal volume of water, can be found in the laboratory by weighing the body in air and when submerged in water. By subtraction, the apparent loss in weight can be found and used in the denominator of the above expression.

1(b). **Archimidean spiral.** If a point moves at constant speed along a given straight line OP whilst being rotated at a constant angular velocity about a point O, the curve generated will be an Archimidean spiral.

2. **Tempilstiks.** Name given to a series of rods used in workshop processes, such as welding, to indicate a temperature range. Each rod is designed to fuse at a different temperature.

3. **Bessel function.** In solving a differential equation of a particular type, known as Bessel's equation, a Bessel function is used.

4(a). **Voussoir arch.** In this centuries old type of bridge structure, the arch consists of a number of wedge-shaped blocks of masonry—referred to as voussoirs—which are generally arranged symmetrically about a central keystone.

4(b). **Vierendeel frame.** In the construction of culverts and some forms of railway carriage, a rectangular box-type of frame is used. This consists of top and bottom members connected rigidly to the side members.

How *Norgren* AUTOMATIC-DRAIN Air Line Filters REDUCE WEAR On Air-Equipment

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1. Abrasive Materials Filtered
Removes grit, pipe scale, rust and other foreign materials.

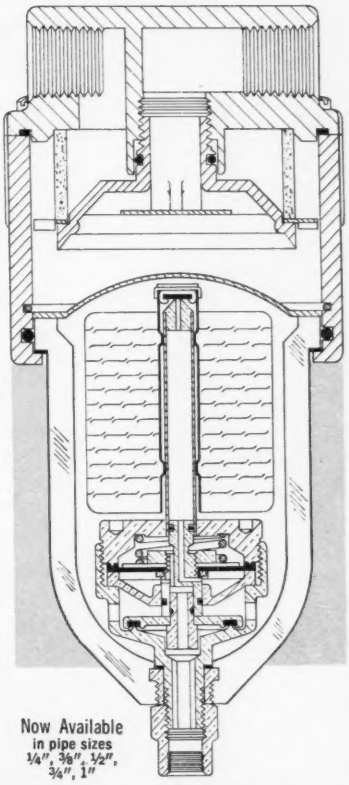
2. Corrosive Liquids Removed
Centrifugal action removes moisture and oil emulsions.

3. Liquids Drained Automatically
Float-controlled, pilot-operated mechanism discharges liquid only when bowl collects 1.6 fluid ounces. Saves compressed air.

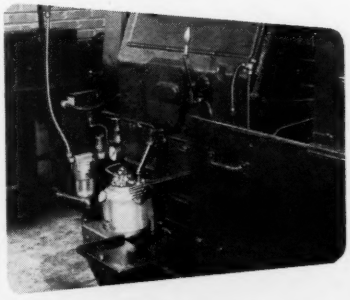
4. Drain Independent of Air Flow
Drain operates under constant or fluctuating pressure with or without air flow.

5. Choice of Filters
Reinforced 200 mesh Monel wire screen (74 micron) is standard. Optional filters are 64 and 25 micron sintered metal.

6. Trouble-Free Drain Operation
Solids are excluded from drain mechanism and clogging is prevented.



Now Available in pipe sizes ¼", ⅜", ½", ¾", 1"



Here, an automotive electrical equipment manufacturer uses Norgren MICRO-FOG to completely lubricate a ⅜" multiple spindle automatic screw machine. On this machine and on many others in the plant, a Norgren Automatic-Drain Filter protects regulator, lubricator, gears and bearings by removing abrasive solids and corrosive liquids from the air line system.

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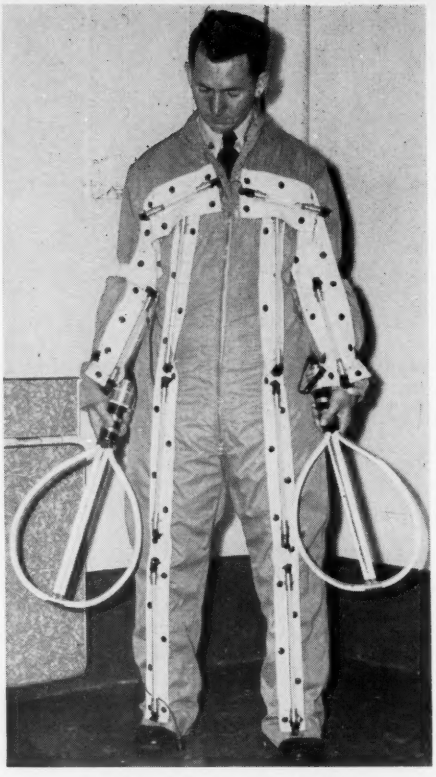
Wherever Air is Used in Industry

Design news in pictures

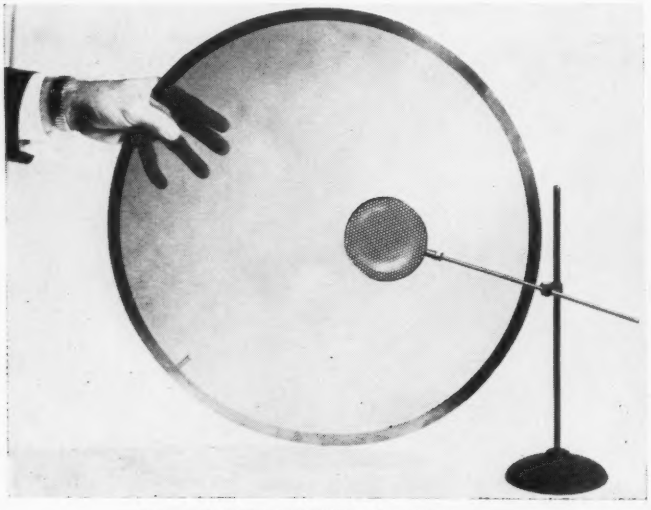
They hope to find oil under Lake Erie

Towing a dinghy astern, a survey boat from Radar Exploration Co. of Toronto moves on between tests to determine the gravitational pull at various points on Lake Erie. The survey (for Imperial Oil) is part of the survey company's search for oil and natural gas in the lake bed. (218)



Lighted suit aids Navy pilots

Modeling the illuminated suit he devised for use by Navy "batsmen" on Canadian carriers is Lt.-Cmdr. Stuart Soward, 31. The suit will be used to guide aircraft landing at night.



Accurate holes 1/100th of an inch across

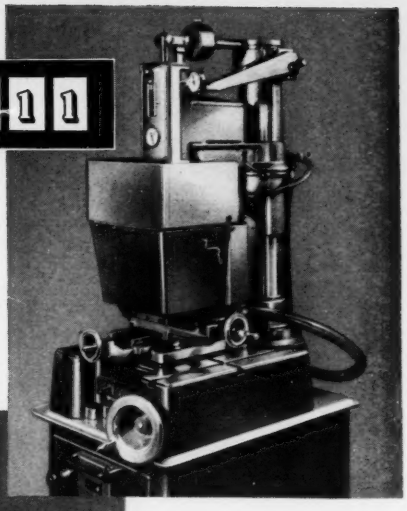
The aperture mask for the color television tube held up in this picture has 400,000 perfect holes etched into a paper-thin metal sheet. The magnifying glass shows the uniform hole size and location necessary in the aperture mask to ensure accurate direction of electron beams. (220)

Back from the stratosphere

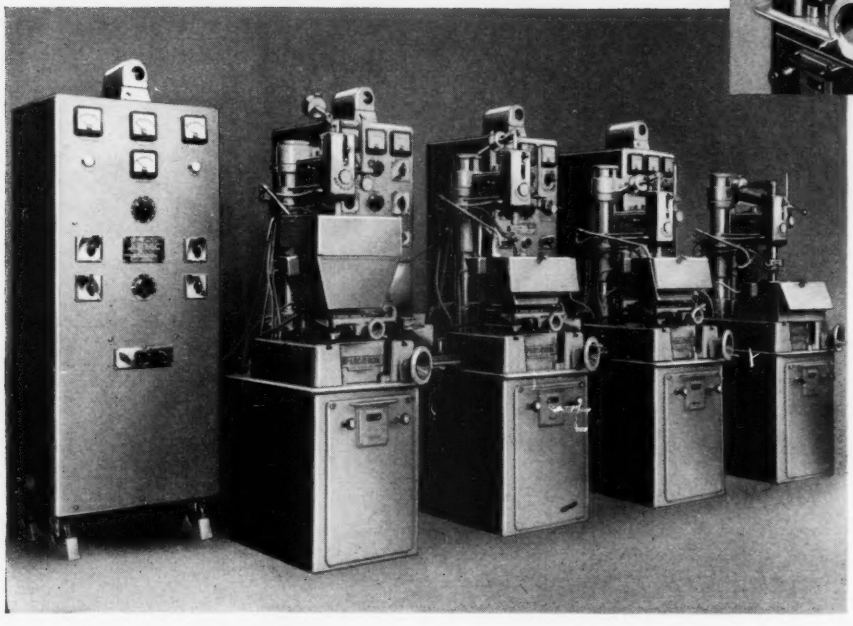
Covered in frost after spending some time in a Tenney Stratosphere Chamber, a guided missile emerges from a simulated test flight at 100 deg below zero at an altitude of 90,000 feet. (221)

SPARCATRON Mk. III

6.5kW



The greatest advance since SPARCATRON established spark erosion machining on a commercial basis



Up to four spark-heads can be operated from one control cabinet. The current is automatically cut off when the electrode has penetrated the workpiece to a predetermined depth allowing one operator to supervise a number of heads.

CAPABLE of operating three to eight times as fast as the Mark II model, depending on the type of material and finish required, the latest SPARCATRON spark erosion machine, Mark III, has exceptional accuracy and increased capacity. The new design also features ease of access for loading the table and setting the servo-head and the facility for quick and accurate alignment of the electrode. SPARCATRON affords the best means of "cutting" intricate shapes, profiles, forms, or impressions in both hard and soft current-conducting materials.

SPARCATRON

Pioneered and established in the toolmaking industry for spark-machining and reconditioning press tools and dies and wire drawing and extrusion dies in cemented carbides and hardened steels. There are extensive applications for "cutting", reconditioning or altering flat and tangential form tools and similar components.

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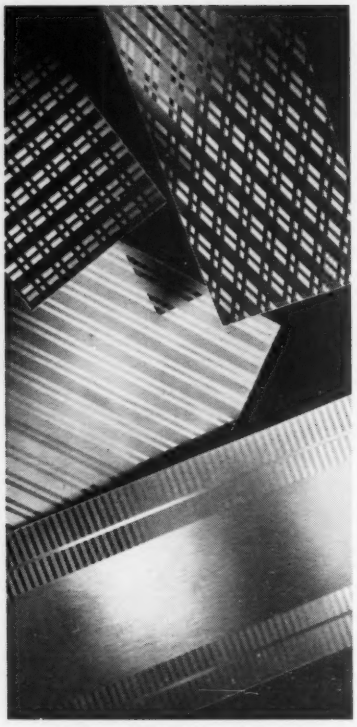
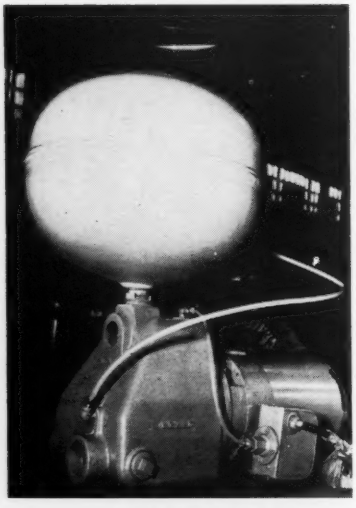


Patterns integral with metal

The variety of machined finishes which can be obtained on pre-finished metals is virtually endless. These are available in sheet, strip or coil. (222)

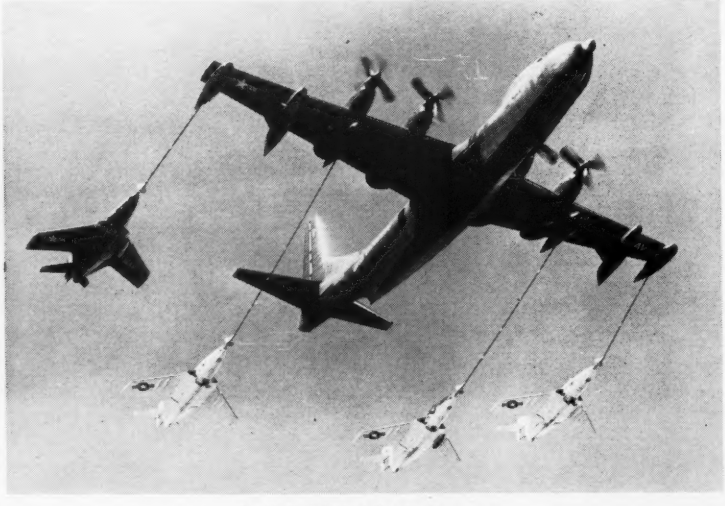
A fork that lifts from the side

Fork truck with a difference is this one made by Irion of Stuttgart. A side operating carrier is specially suitable for handling long materials and has a 6,600-lb payload. All operations for raising and lowering the load are hydraulic and the drive comes from a 30-hp diesel engine. Speed is 15 mph. (223)



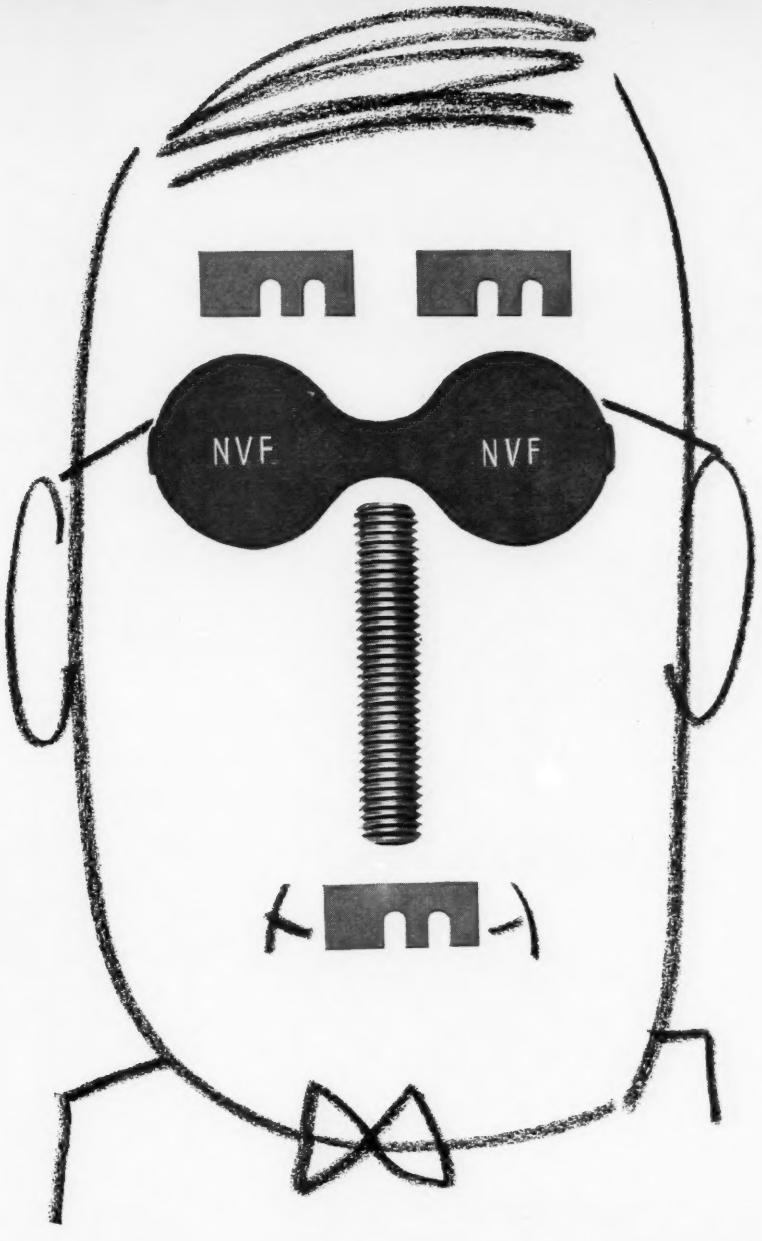
A cost cut in half

A 55-60% saving in materials and labor resulted from using Nylaflow instead of copper tubing in this deep well water pump. It's easily cut. (224)



Aerial piglets take to the sow

Four U. S. Navy jet fighters take on fuel from a Convair R3Y-2 "Tradewind" in the first multiple refueling operation ever conducted from a seaplane. The 80-ton "Tradewind" transport carries enough fuel in its wings for eight fighters. The planes taking a drink are F-9F-8 Cougar jets from Miramar. (225)



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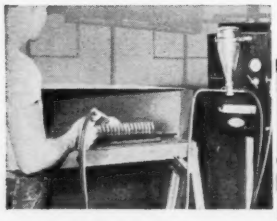
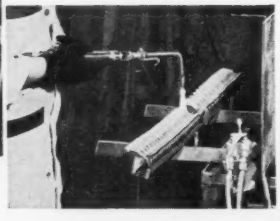
Colmonoy Spraywelding INCREASES Rocker Arm Life

Colmonoy No. 6 hard-facing alloy stopped the excessive metal-to-metal wear between the rocker arms shown and the cast iron cam shafts that operate them. Wear resistant Colmonoy No. 6 is sprayed on with the Colmonoy Spraywelder and fused in with an oxy-acetylene torch.



Rocker arms being sprayed with the Spraywelder.



After spraying, the overlay is fused to the base metal.

Colmonoy Spraywelding makes hard-facing a real cost cutter. It allows the use of less costly base metals, speeds application time, and saves material and finishing time because overlays are smooth and within .010" of desired size.

Write for the Sprayweld Catalog. For a specific recommendation tell us about your part, and the wear encountered.

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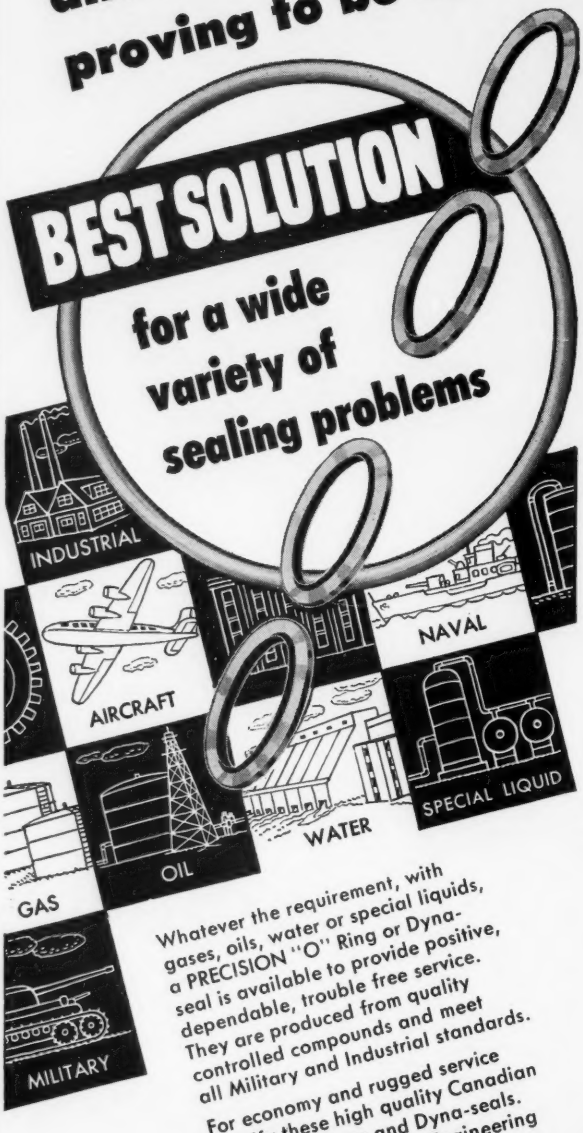

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Illustration shows Aluminum Sand Cast Wheel Tail Fork produced for De Havilland Aircraft of Canada Limited

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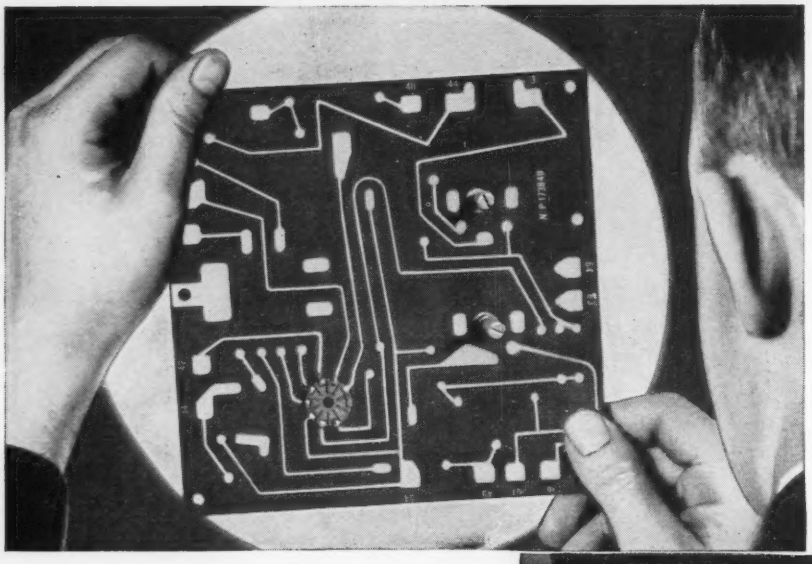
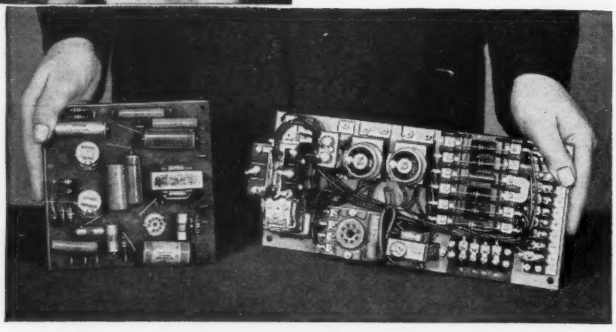
G-E Adjustable Speed Drives cost up to 20% less with Printed Control Circuits . . .



Shown here is the "brain" of the new general purpose G-E Thy-Mo-Trol Drives. Here an electrical diagram, or electrical "track", is printed on the back of a sturdy plastic board. This "track" consists of solder-covered copper strips which connect all circuit components without the use of wiring.

NOW! GET RELIABLE, SMOOTH, ADJUSTABLE SPEED FOR MACHINE TOOLS IN A SIMPLIFIED LOW-PRICED DESIGN!



Here is ample evidence of the simplicity and reduced size made possible by the new G-E printed control circuit system, left. At the right is the conventional type. Note its larger size and complexity.

By adapting printed or "wireless" circuits to a completely new line of G-E* Thy-Mo-Trol Drives, C.G.E. offers industry electronic adjustable speed drives at up to 20% reduction in cost.

These drives consist of an electronic control panel, a DC motor, and a push-button station. The big price difference is made possible by the use of printed circuits in the control panel. Designed for quality performance, reliability and easy maintenance, these G-E Thy-Mo-Trol drives are available in two ratings: ¾ to 1 hp and 1½ to 3 hp. They feature reductions in weight, size, circuit complexity, wiring, and maintenance and installation costs. They supply constant torque over the entire speed range, which is 8 to 1, with higher ranges possible for special applications.

For further information on these outstanding new low-cost drives, contact your nearest C-G-E office or write to: Apparatus Department, Canadian General Electric Co. Ltd., 107 Park St. North, Peterborough, Ont.

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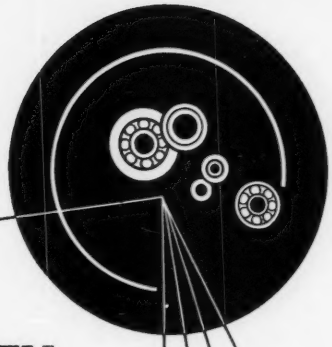

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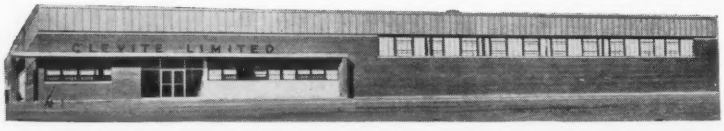

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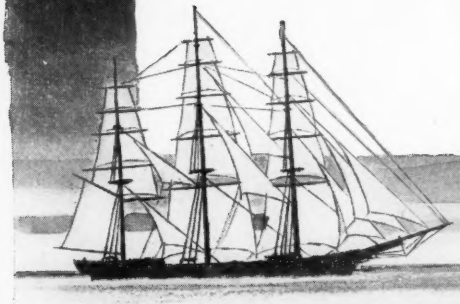

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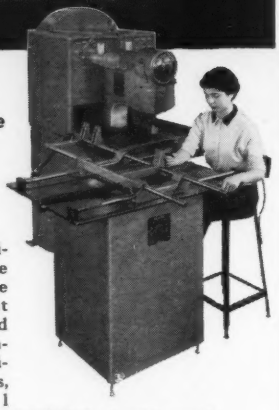

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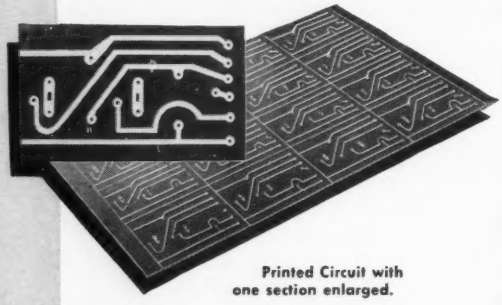

Printed Circuit with one section enlarged.

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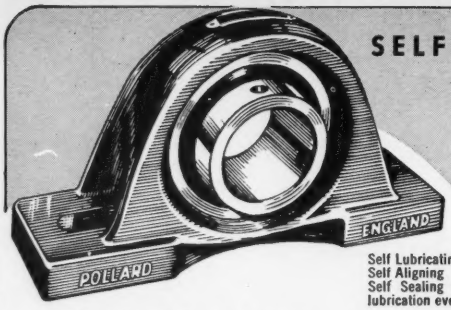

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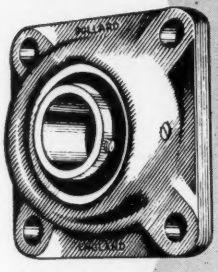

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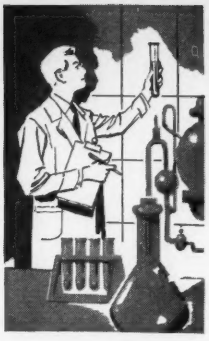

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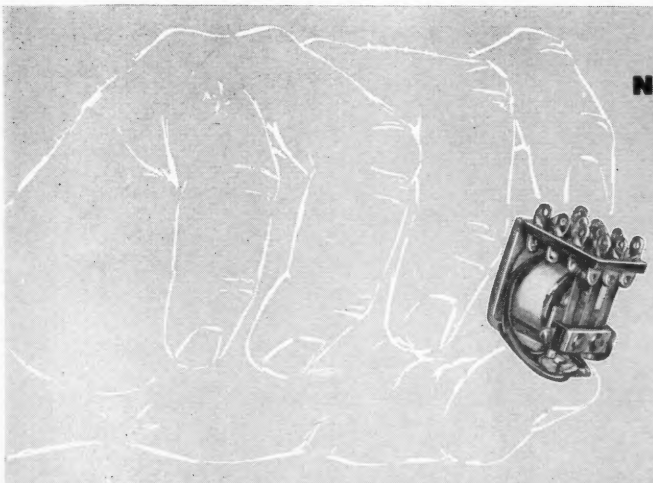

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COIL RESISTANCE: Up to 6700 ohms
COIL POWER REQUIREMENT: 1 watt
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PULL-IN: 75% of nominal voltage
TERMINALS: Solder lugs

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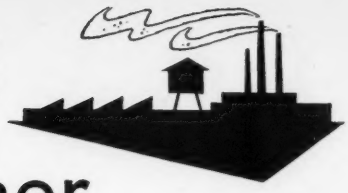

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Editorial

A co-operative plan of education

We have previously had occasion to refer to the proposed University of Western Ontario's technical and engineering course at Waterloo College and we are not at all surprised that this most excellent idea has been so well received by industry. More than 150 large companies, using engineers and technicians in practically every field have, in fact, indicated an enthusiastic interest in seeing the course developed to completion.

We understand from J. G. Hagey, president of the College, that development work is proceeding reasonably satisfactorily and that they are quite optimistic about the possibility of being able to offer the first year of the course in the fall of 1957.

That the matter is extremely urgent would never be gathered from this statement which savors, in fact, of a typical Royal Commission, where any old time will do.

It is, of course, an entirely new type of education for Canada and it is highly desirable for the matter to be completely investigated before a decision is made to offer the course. It should not be forgotten, however, that similar co-operative schemes have been used in the States for years and this should have the effect of shortening the time of investigation.

For the research work that is required there has been a provincial government grant of $25,000.

The program divides the students into two sections, (A) and (B). These alternate college and industrial training periods so that whilst (A) is in college (for thirteen weeks), B is in industry.

The first two years will be taken by all students, the second year serving as a pre-engineering course to provide a better foundation and hence a more gradual transition to heavy mathematics and science and so help to reduce the present rather alarming failure rate of 50% in the first two years of engineering.

After these two years, students will be qualified to proceed to a third year for a technical diploma or alternatively to the first of a four-year degree course in engineering.

The organizers are urged to leave no stone unturned so that the course may start not later than the fall of next year. Further delay should not be contemplated for one moment.

William Morse.

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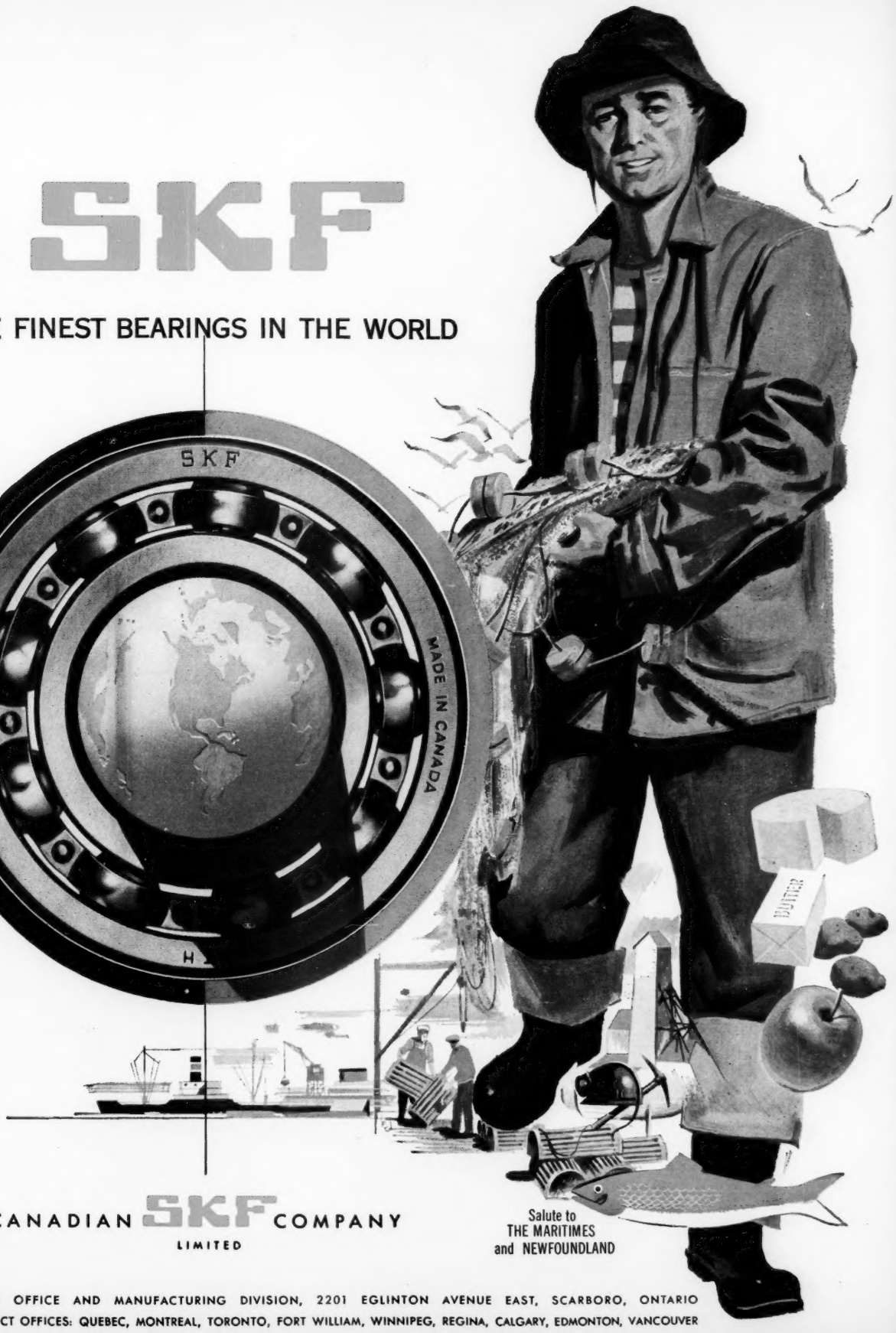

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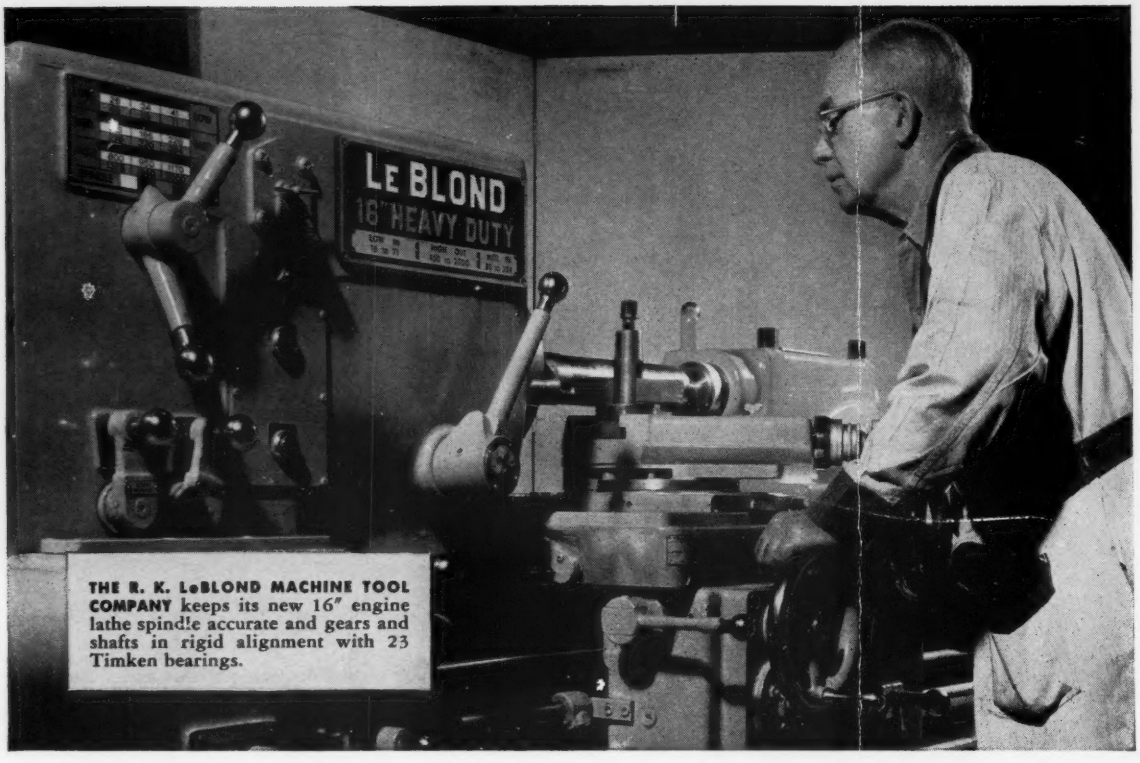

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16 or 2000 RPM—23 TIMKEN bearings take varying loads on LeBLOND 16" engine lathe

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Wherever wheels and shafts turn, Timken bearings are the standard of excellence. They virtually eliminate friction. Their full line contact insures extra load carrying capacity. They're engineered to give true rolling motion; and they're precision manufactured to live up to their design. We even make our own steel to insure the highest quality.

When you buy or build machines, make sure you specify Timken tapered roller bearings. They're your No. 1 bearing value. The Timken Roller Bearing Company, Canton 6, Ohio, U. S. A. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

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